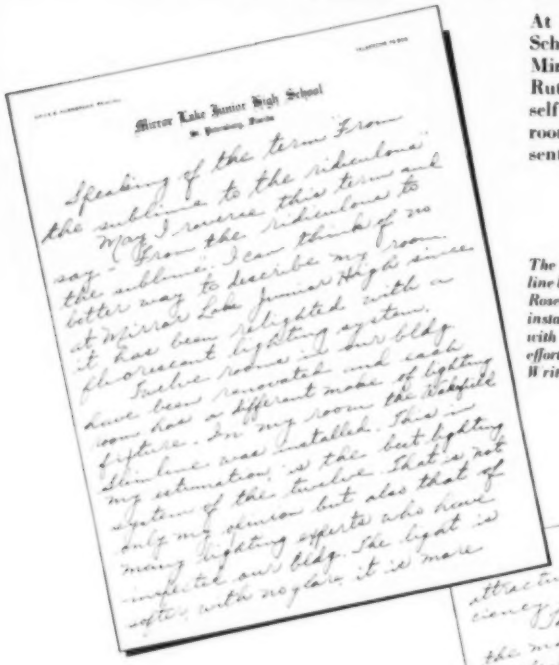
ILLUMINATING ENGINEERING

AUGUST, 1949

Relighting Schools—A Community Project
Lighting a Sectional Exhibition Case
Luminous-Ceiling Lighting
A Little Light on Color
Lighting a Printing Press
Cold Cathode Characteristics
Photometry of Floodlights
Lighting a Dining Room

THE JOURNAL OF THE ILLUMINATING ENGINEERING SOCIETY

The Children Brought Their Parents To See <u>This</u> Newly Lighted Classroom



Mirror Lake Junior High School
St. Petersburg, Florida

Speaking of the term "From the sublime to the ridiculous" may I reverse this term and say "From the ridiculous to the sublime". I can think of no better way to describe my room at Mirror Lake Junior High since it has been relighted with a fluorescent lighting system. Twelve rooms in our bldg. have been renovated and each room has a different make of lighting fixture. In my room the Wakefield Slimline was installed. This in my estimation is the best lighting system of the twelve. That is not only my opinion but also that of many lighting experts who have inspected our bldg. The light is softer, with no glare, it is more attractive and the lighting efficiency one of the highest. This is also the opinion of the majority of my students. The children are more alert, happier and the general morale is greatly improved. This is evidenced by the fact that so many have brought their parents in to see it. If you have never sat in the gloom trying to read and had some one suddenly turn on a light you can have no conception of our old and present lighting.

Since we had no choice in the lights to be installed in our rooms, and since I like mine so much better, I consider myself very fortunate in getting the Wakefield Slimline.

Ruth D. Downer
Social Studies
Mirror Lake Jr. High

(Wakefield)

At the Southeastern School Lighting Institute and School Lighting Exhibit held April 19, 20 and 21 at Mirror Lake Junior High School, St. Petersburg, Fla., Ruth Downer, social studies teacher, expressed herself so enthusiastically about the new lighting in her room, that we asked her if she'd mind putting her sentiments into a letter. She did, and here's her letter:

★ ★ ★

The installation consisted of 3 rows of Wakefield Stars with Slimline lamps. The Wakefield Star has proved itself outstanding in the Rosedale School experiment at Austin, Texas, and in many other installations. If you are concerned over providing your students with a visual environment in which seeing becomes relatively effortless, we have much valuable information and data for you. Write The F. W. Wakefield Brass Company, Vermilion, Ohio.

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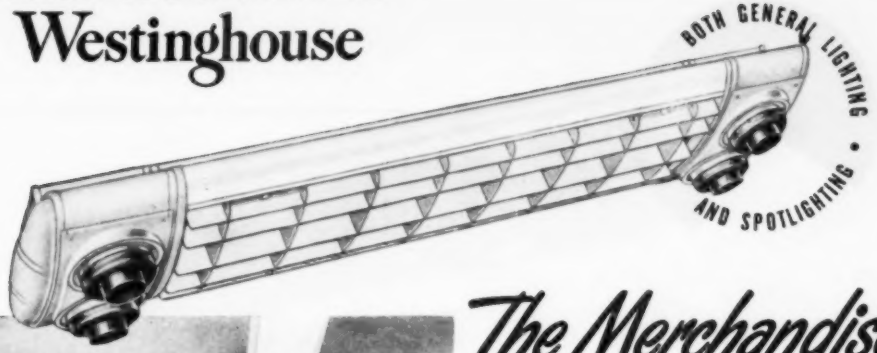

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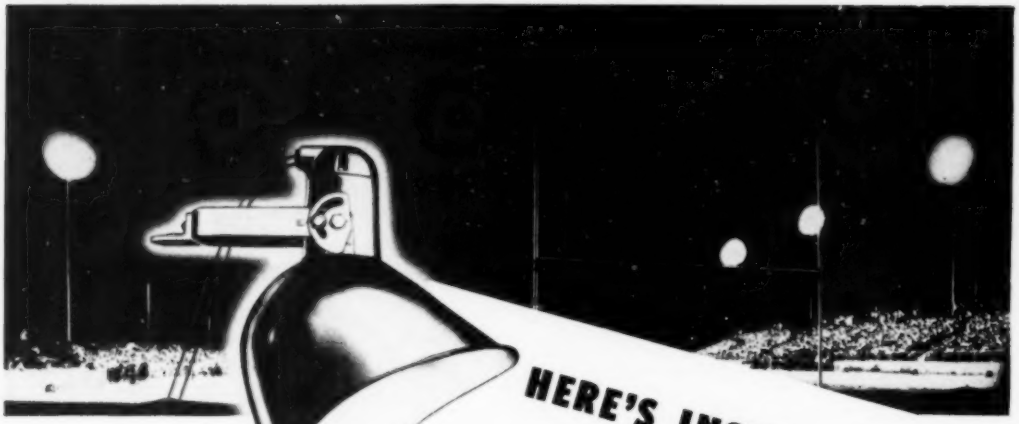

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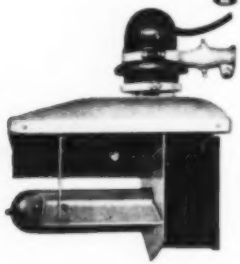

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ILLUMINATING ENGINEERING

THE JOURNAL OF THE ILLUMINATING ENGINEERING SOCIETY

AUGUST
1949

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Some Observations—

ONE OF THE PRIVILEGES afforded the Society's President is the opportunity to be included on the Regional Conference Programs in the Canadian and U.S. regions of the Society. This year it was my privilege to travel from coast to coast, attending Regional Conferences at San Francisco, Portland, Toronto, Rochester, Hartford and Harrisburg. In addition, the Midwestern Region held a one-day Conference in Milwaukee. Many of our members in this Region were busy with the forthcoming French Lick Conference and therefore scheduled a condensed program. Conflicting dates prevented my attending the Southwestern Conference and consequently meetings were scheduled in Dallas, Houston and San Antonio with Section and Chapter Officers and members. This was most valuable.

REGIONAL TECHNICAL Conferences are growing in importance and strength year by year. I have heard many excellent papers and application symposiums providing timely and much-needed knowledge in a rapidly expanding field. It was gratifying to see many of our members presenting their first papers. This is of vital importance. While it is essential to hear from established authorities, it also is important to see new author names listed on the programs.

I HAVE TWO suggestions to make regarding the programs for Regional Conferences. I have observed the tendency to overcrowd because of the abundance of material available. It is all extremely valuable, but a mistake is made in not providing sufficient time for discussion from the floor. Without such discussions, we no longer have conferences, but merely a series of lectures. The whole tempo of the meeting lags where we only sit and listen. Conversely, an increased level of interest is immediately established when delegates are given the opportunity to express their views from the floor. Unless discussion time is planned and provided, I predict our Regional Conferences will lose their appeal.

THE SECOND suggestion is to plan a Local Activities Meeting as a part of each Conference. It could possibly be scheduled as an evening round table discussion by Section and Chapter Officers within the respective Region. Many local operating problems could be aired at such a session and a greater appreciation of the overall functions of the Society could be gained.

IN ADDRESSING the Regional Conferences I stressed, in each case, a greater use of the Society's publications. It was surprising to learn how few members knew of the mass of material available at our Headquarters office. Our American Standard Practices, Recommended Practices, and Reports represent the means of performing the primary function to the membership; namely, the advance of knowledge of the Art. As new reports are published they should be announced and digested at Section and Chapter meetings so that we all know the nature of the published material and can avail ourselves of it. Many man-hours of voluntary effort on the part of the committee members are spent in developing and preparing reports and the product of their efforts can have far-reaching effect if used.

THE SOCIETY'S Section and Chapter structure is strong, and growing in strength. Charters were approved this year to new Chapters in St. John, New Brunswick, in the Maritime Provinces; Winnipeg, Manitoba; Quebec City, Quebec; Charlotte, North Carolina; Nashville, Tennessee; and Miami, Florida. In addition, a charter was extended to a new Student Branch at the University of Cincinnati. New Chapters are now shaping up in western Michigan, the Hawaiian Islands, Mexico City, and New Mexico. These are signs of healthy growth and active member interest.

THIS HAS BEEN a busy year, but also one of great value. The meeting again of many old friends and the gaining of new and valued friendships was a distinct privilege. To observe the continued enthusiasm in a growing field of endeavor is reassuring. The ready willingness of our membership to volunteer for work in the highly ramified functions of the Society is an experience never to be forgotten.

IN TRAVELLING across the United States and Canada, one additional observation stands out in clear focus. This is a huge Continent — great distances separate many of us. It is a beautiful Continent, filled with scenic grandeur to match any place in the world. It is a rich Continent, rich in natural resources, rich in the freedom of the people who have settled on its farms and in its cities. It is worth preserving and protecting from those who insidiously wish to destroy it. That decision is our individual responsibility. Let us keep our Countries — Canada and the United States — and not hand them over to idealogical despots. From the North to the South; from the Pacific to the Atlantic, it is our America, and its glory must never be dimmed.

L. E. Tayler

L. E. TAYLER
President

The Relighting Project of the

By CHARLES R. CORNIC

HOW MANY of you are more than just casually acquainted with your School Superintendents and the members of your Boards of Education? Unless you really *know* these people, and other School personnel, you are indeed handicapped in attempting to improve the *seeing* (I like that better than "*Lighting*") conditions in your school systems. They *may* be more "light conscious" than you have any idea of. It is necessary for you to know what their reactions are before you can determine your logical starting point. Every effort you put forth to improve the seeing conditions in your schools is indeed a worthy one. It is more than just probable that some of you are wearing glasses today because of the very poor seeing conditions in the schools you attended.

Fortunately for me and all others concerned, the members of the Board of Education of the City of Birmingham, and particularly its President, Mr F. D. McArthur, were conscious of the *need* for better seeing conditions in our schools. I had no "selling" job to do on that score. When the Board requested a vote on a bond Issue, they *wanted* so much to improve the poor seeing conditions, that lighting was included and given as much publicity as the new building program. My prediction is that a thorough canvass would disclose a microscopically small number of members of boards of education, superintendents, and other school officials who do not realize fully, the *need* for improvement in lighting. *Your* job is to make them *want* it enough to take *action* on it!

Prior to May 1, 1942, the date I assumed my duties as business manager, the commercial department of the local public utility company had been responsible for the limited improvements in lighting that had been made in the Birmingham schools. When fluorescent lighting was developed to the point that it was considered practical, there was not enough money in my portion of the budget to buy so much as *one* fixture for any school. The Parent-Teachers Committee members visiting my office in the interest of better seeing conditions in their respective schools, were so informed. Then, one committee member asked, "what if *we* buy the fixtures?" My department could absorb the wiring and installation costs. We started with that.

The lighting men of the local utility company were called upon for recommendations and layouts. These were followed to the letter, with most gratifying results, and several scattered installations were made. Sometimes there was money for only one row of fixtures. One PTA raised enough to buy fixtures for three complete rooms, but decided to partially relight six rooms instead. In such cases, the layouts were made just as though the installation was to be completed, then only the *inside* row of fixtures was put up and connected.

The author is Business Manager of the Birmingham, Alabama, public school system.

This article presents the essential substance of a talk given before the 15th Annual Sales Conference of the Edison Electric Institute, Chicago, Ill., April 5, 1949.

Figure 1. Library in a Birmingham school showing typical lighting conditions before relighting project was undertaken. Woodwork and chairs are stained dark mahogany.

Birmingham School System

In June, 1944, we made a few trial installations of fluorescent lighting in our high school lunchrooms and kitchens. Results were so gratifying that the lighting of classrooms became our next objective.

When bond funds became available, our Board did not want to be in the position of having to answer possible questions with "recommended by our Business Manager," or "recommended by the Birmingham Electric Company," so an appeal was sent to the highest known authority on school lighting to make a survey and tell us whether what had been done up to that time was in the right direction or not. Mr. J. M. Ketch of Nela Park, and Prof. R. C. Putnam of Case School of Applied Science in Cleveland, came to Birmingham, made the requested survey, and, in a Board meeting, confirmed that we were moving in the right direction. The business manager was given the "green light."

The interested citizenry voted favorably on a $7,000,000 bond issue requested by the Board of Education, in November, 1945. The proceeds were to be used for new buildings, additions to existing buildings, a complete relighting project, and fireproofing boiler rooms and other areas in several old buildings.

The relighting project actually got under way June 10, 1946 and was scheduled for completion by mid-July, 1949. It included nearly 1500 classrooms and shops, rest rooms, toilet rooms, corridors, stairways, boiler rooms, and storage rooms. When completed, all classroms and shops will be equipped with fluorescent lighting. Other areas are being relighted with incandescent lamps. It is probable that in the not distant future the lighting in the corridors, particularly those lined with lockers, will be changed to fluorescent.

To accomplish the desired objective successfully meant, and means, new entrance services and switches in most buildings; new "feeders" to new "multi-breaker" type distribution panels; new wiring throughout. Handicapped by inability to effect other than an intermittent flow of needed materials (this until late in 1948) progress has been slow, but nevertheless steady.

Our average classrooms are 22 to 23 feet wide, and 30 to 33 feet long. In most of the rooms that have the chalkboard area across the front and along the side only, we install two continuous rows of 6 fixtures each, making a total of 12 fixtures in such rooms. The front end of each row is spaced a distance of not more than 30 inches from the front wall. It is then extended toward the rear of the room as far as the 6-fixture line will take it. Occasionally, the crowded seating arrangement requires 7 fixtures per row. Also occasionally, the rear wall is covered with chalkboard, in addition to the front and side wall. In such cases, 7 fixtures per row are installed. Rooms of other dimensions receive fixtures in proportion. We thus get, in overall results, a range of 30 to 40 (average about 33) footcandles of light on desk surfaces. (Initial values.)

For the relighting of classrooms, we standardized upon a direct-indirect fixture with luminous plastic side panels and using two 40-watt fluorescent

Figure 2. Same library after completion of relighting project. Woodwork was first coated with aluminum paint and then finished in pastel shade.

lamps.

In the manual training and other shops, we use 2-lamp and 3-lamp industrial type fixtures. We have some continuous row, some "spot" installations, some shielded, some bare lamps, depending upon the nature of the classwork. The 4500° white has been standardized upon.

We do not know, and doubt whether any *authority* knows at present just what footcandle level will be considered as "standard" in years to come. In our case, from nearly zero footcandles to an initial average value of 33 is quite a jump!

In the rewiring part of our project, we are looking into the future to some extent at least. New entrance services are oversized fully 50 per cent. Main distribution panels, likewise. A minimum of four "blanks" are provided in each branch distribution panel so that additional circuits may be connected when required. Where we now have motors of one hp or larger, and the total power load equals approximately 5 hp or more, or will equal or exceed 5 hp within a reasonable time, entrance services not only are increased in capacity, but changed to three phase. Feeders to the branch distribution panels are also 50 per cent oversize.

In our oldest buildings, the wiring was knob-and-tube type. This was disregarded, by-passed, and

Figure 3. Face of typical Survey sheet for permanent record. Reverse of sheet carries sketch of floor plan. When the project is completed, one of these sheets will be on file for each relighted room.

LIGHTING SURVEY

BIRMINGHAM PUBLIC SCHOOL SYSTEM

SEE OTHER SIDE TO.

Mark Location of Teacher's Desk

Sketch of { Doorways — Cloak Rooms — Window Locations / Rooms — Skylights — Stage, if in Class Room / Give All Dimensions }

Sketch In Any Irregularities and Mark Dimensions of Them.
Sketch Pipes Giving Exact Locations and Distance From Walls and Ceiling.
Sketch Stairs

NUMBER AND TYPE OF FLUORESCENT FIXTURES

Commercial, With 2 Tubes 40 Watts Each. Reflector? Shielded?

Individual ..... Commercial, With 4 Tubes 40 Watts Each — Shield? ..... Open? .....

Industrial, With ..... Tubes ..... Watts Each — Shield? ..... Open? .....

Germicidal With 1 Tube ..... Watts Each.

Mountings: Pin, Stem, Stud

Remarks: "Daily board across front of room, only. Windows at rear, and both sides. Windows on North and West open to the outside. Windows on South open to outside alley, but in a court. This room, and adjoining similar room of equal dimensions (No. 712) supplied singlefe survey through individual "feeder" line, direct from the switch board. Total lighting load, 2000 watts.

TABLE I.—Comparison of Power Consumption and Costs for Typical Schools

	1945-46		1946-47		1947-48	
School	**KWH**	**Cost**	**KWH**	**Cost**	**KWH**	**Cost**
Cunningham School	4812	$ 152.	28090	$ 883.	38030	$1198.
Lakeview School	20215	637.	35349	999.	38880	1108.
Martin School	7318	231.	15227	480.	29520	929.
Phillips High	120720	2881.	198920	3982.	244510	4444.
Parker High..	50400	1340.	76880	1759.	154720	2994.

surface-mounted metal molding used. In the buildings originally wired in conduit, the old wires, (chiefly two No. 14) were pulled out and replaced with oversize Type T, or Type RU wires. In some cases it has taken the combination of both to gain the objective.

Each room is on an individual circuit, with a control switch for each row of fixtures. Greater flexibility is thereby provided. A minimum of two convenience outlets per room are connected. Three Type T or Type RU wires feed each room, originating in new "multi-breaker" distribution panels, some in entirely new locations. For runs up to 40 feet, three No. 12 wires are installed. For runs from 40 to 60 feet, three No. 10 wires are used. Each floor (we have some *three*-story buildings) has one or more "multi-breaker" type distribution panels, located so that no circuit has longer than a 60-foot run. Tests *at the fixtures* have proved that this procedure, coupled with adequate transformer capacity, insures ample voltage at all times; a *must* for the successful use of fluorescent lighting.

With the understanding that longer lamp life and reduced operating costs would result, we chose conventional starters instead of the instant type. However, if we were inviting quotations now, we would ask for alternate bids on fixtures of both types, if for no other reason than for comparison.

The entire relighting job is being done by our own staff of workmen under the supervision of our chief electrician. The business manager carries the full responsibility. During the summer vacation periods, June, July and August, our staff is augmented by instructors from our high schools. They also help us on Saturdays and during holiday periods. We have eight such men. Contrary to the adage "He who can, does; he who can't, teaches," these eight men have definitely proved that they can *do* as well as teach! Then too, we have three "GI Trainees" from "On-the-Job Training" program, one with each journeyman electrician.

On the basis of our methods of procedure, excluding all painting, we have arrived at an average cost of approximately $300 per classroom for re-

Figure 4. A typical Birmingham classroom after relighting, which included refinishing of woodwork to light pastel shades.

lighting. This is the result of totaling all costs (fixtures and accessories, all other materials, and labor) and dividing the total by the number of classrooms. This figure includes all areas relighted with incandescent type lighting.

Operating Costs

A comparison of power consumption and costs for several of our schools is given in the accompanying tabulation. It must be emphasized that the increases shown are *not* all due to our greatly increased lighting. We have added a number of electrically operated pieces of lunchroom equipment, such as dishwashers; food warmers; bake ovens; beverage coolers; ventilating fans; water coolers; and in our home economics classrooms, electric water heaters. All these have had their influence upon energy consumption.

Let's see what such costs mean on a per-pupil basis. In Statistical Circular No. 245 issued in September 1948 by the Federal Security Agency, you will find a disclosure of "Annual Expenditure per Pupil in Average Daily Attendance," and the "breakdown" thereof. As you study it, your first thought probably will be to wonder how the given figures compare with similar figures in your own school system. Then, it *should* lead you to wonder *how much* of the annual expenditure per pupil is paid for electric service. That should provide you with quite a "target." In our own system during the year 1947-1948, our annual expenditure per pupil was $121.15, for an average daily attendance of 41,166. Electric service cost slightly more than $1.00 per-pupil-per-year. This was not just for lighting. Even if it were, it would indeed be reasonable. It was for *all* electric service of every nature. If any of you are "stymied" in your efforts because of an aggregate sum that looms large in the minds of members of your school boards, sift it down to a per-pupil-per-year basis, and show how small it really is.

Another source of useful financial statistics is the annual report that is published in some form by most if not all school systems. Such reports usually contain charts or diagrams showing the various sources of school revenues, and also the various disbursements. In all instances it will be found that by far the *highest percentage* of disbursements goes for instruction — salaries to principals, supervisors, department heads, and teachers. In the Birmingham System, 84.68 per cent, 84.68 cents out of every dollar, was paid in 1947-48 for this purpose.

Try to estimate, if you can, just how much of this money is *actually wasted* because of poor seeing conditions, and other morbid surroundings. No matter how much teachers' salaries may be, teachers cannot deliver their best efforts nor get maximum results from their efforts, under the conditions which prevail in a high percentage of classrooms. You can use this information as a major point in developing an interest in making improvements; in trying to bring "the powers that be" to *realize the need*, and to make them *want* to do something about it.

Many cities have compiled or are compiling current reports of schools' needs in the form of new construction or modernization. As an example, I have in mind a "Report of Construction Needs of the St. Louis Board of Education." The Board of Education of Worcester, Massachusetts has compiled a similar report, much more elaborate and far-reaching. Why mention these? Because, such reports disclose the thinking — not only the present, but the in-the-future thinking — of the men and women charged with the responsibility of handling our educational affairs. My strong recommendation is that you learn what department of your school system prepares these reports, then keep in sufficiently close contact with such department so as to be sure to obtain copies of every one. You have but to look at the contents to recognize their value.

A Little Light on Color

By JULIAN ELLSWORTH GARNSEY

Because color and its utilization are of direct concern to everyone interested in effective lighting, a repeated discussion of the subject, from different points of view, seems desirable. This personalized message from a noted colorist is aimed at every individual in the lighting field. Some challenging thoughts and opinions are given. Discussion is invited.

LET ME REMIND you of the great influence that color plays in the daily lives of all of us, this in spite of the fact that the lighting specialist normally acts on the belief that illumination is the principal element in human life.

You rise in the morning from the rose-colored blankets with a dark-brown taste in your mouth, owing to having painted the town red, the night before. You stagger into the bathroom and locate green-handled toothbrush, cream colored soap and pink towel by color. You then choose a tan, blue or gray suit, with tie to match in color (you hope) and go down to breakfast. Your wife sends you right back upstairs again to change the tie for one she prefers with that suit. Back at the breakfast table, your coffee must have a certain golden-brown hue, not greenish, your toast a red-brown, not blackish, and the yolk of your egg must be orange, not dark red. On the way to the office, in the car whose color was chosen by the Mrs., you stop on red, go on green, and pay no attention whatever to the yellow-and-black "Slow" signals.

Arrived at the office, you open the mail: first the yellow envelope containing a telegram, then the red-white-and-blue bordered air-mail envelopes, and finally the plain white-and-black ones. At the end of the day's work and after the dinner of red roast beef, green peas, white potatoes, and strawberry ice cream, you pick a Technicolor movie, not a black-and-white. At home again, you glance over the color pages in *Esquire* and turn in under the rose blankets.

In all these and many other decisions during the day, you have been the unconscious servant of color and a lot of chaps like myself have been working hard to influence you by color for the profit of our clients. How do we go about *our* jobs?

In the first place, we keep in mind exactly what color is and, secondly, we are guided by the peculiar nature of the human eye and the mental sensations which the messages, transmitted by it to the brain, evoke in the human mind. I shall talk first about what color is, and then about human vision.

By different but converging roads both the lighting specialist and the color specialist are working toward the same goal: easier seeing and happier surroundings. To both, a better mutual understanding of the common problems so generally neglected would be of practical value. Therefore, I would like to take you on a little inspection trip along my road for a few minutes, to see how our mutual problems look from the viewpoint of a professional colorist. In the interest of conciseness I shall avoid discussion of theories behind the principles of color, which often conflict anyway, and must of necessity make unqualified statements which may be subject to debate. My objective is to keep this discussion on a severely practical basis and therefore, hopefully, to furnish some thoughts which may be useful in the lighting business. To round out my story I must mention some topics already familiar to many of you. I hope that by the time I have finished you will think less of footlamberts, footcandles, amperes, and watts, and more of the human reactions to light and color that are the final criteria of our success or failure.

How Red Is a Tomato?

Color arrived in the world simultaneously with light when the Creator said, as recorded in Genesis 1-3: "Let there be light." Obviously without light there can be no color, although light can exist without color. The lighting expert is one up on the colorist there. [Ed. note: this is something like the story of the hen and the egg.] But light and color have been inseparable partners ever since that day at the dawn of creation. Now, it is old stuff to say that white light consists of all visible hues, bound together into a sheaf about 125 to 160 in number—that the sheaf may be separated into its components by passing a beam of that light through a prism or a rainstorm to form a rainbow, and that the separated hues are called the *spectrum* of that light.

This article presents the essential substance of an address delivered before a technical conference session of the Commercial and Industrial Section, National Electric Manufacturers' Association, held as a part of the program of the Third International Lighting Exposition, Chicago, Illinois, April 1, 1949. Mr. Garnsey is a professional colorist of note whose work at the Texas Centennial Exposition in 1936 and at the New York World's Fair in 1939-40 is widely known.

NAME	SYMBOLS	
RED	5	R
YELLOW-RED	15	YR
YELLOW	25	Y
GREEN-YELLOW	35	GY
GREEN	45	Y
BLUE-GREEN	55	BG
BLUE	65	B
PURPLE-BLUE	75	PB
PURPLE	85	P
RED-PURPLE	95	RP

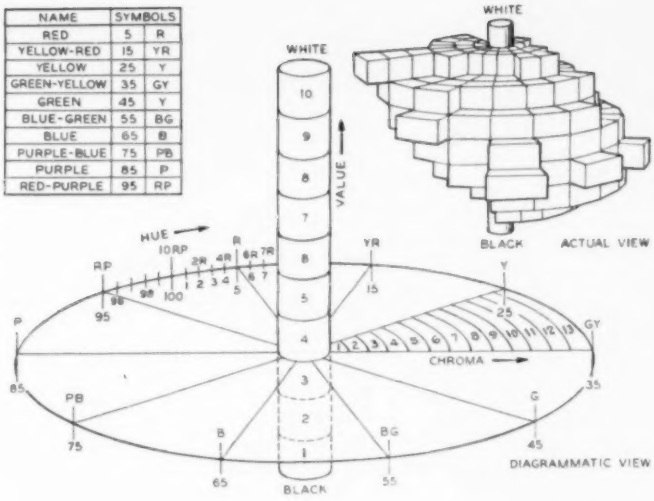


Figure 1. Common forms of Munsell color solids showing notation scales by which colors are designated according to their position in the solid.

It is necessary in our work to have a system of identification of these hues of the rainbow and their derivatives which embrace all colors seen upon earth. We can do this by applying three terms of nomenclature: hue, value and intensity (or chroma). These are old-fashioned terms with which pure scientists may quarrel but which, for several reasons, I find adequate. By *hue* I mean the first recognized attribute of color. We may say an apple is green, a tomato is red, the sky is blue, and so on, without further definition. But that is not sufficient, except for primitive peoples. We want to know how light or dark the color to be described is, and how strong or weak. So our second term is *value*, relative lightness or darkness, regardless of *hue*. A lemon is lighter, "higher in *value*," than an orange, and both are lighter than a tomato. We say "higher or lower" in *value* because we naturally think of darks as being lower down, vertically, and lights as being higher, vertically, than the normal. Then, finally, we want to know whether a color is strong or weak in power, regardless of hue or value. So we use the term *intensity or chroma*, and reckon this quality by comparing it with a colorless, neutral gray and by estimating how many steps in visual comprehension it lies from that gray.

Thus we have three dimensions of color: *hue*, *value*, and *intensity*, and you will readily see that these may be nicely expressed in a color solid if the hues are displayed in a closed circle, horizontally, if values appear vertically from darkest to lightest, and if intensities are plotted outward from the neutral gray pole, growing stronger as they get farther away from that pole. A professional colorist thinks in terms of that solid, which has advantages which I cannot delay to explain here. Let us, however, look particularly at the hues arranged in circular form, often called a Color Circle, to learn something from it. (Fig. 1.)

First, we note *complementaries*. A complementary is a color which contains most of the rays of the spectrum not present in its opposite. Take red out of the spectrum and you have green; take out green and you have red, and so on. Or, turning the statement around, if you mix the right complementaries *in light*, you get white light. However, note that this will not work in pigments because, in the case of light, you are adding light to light; you have an *additive* mixture. In mixing pigments you are subtracting light from light, twice, and so you get, not white, but a neutral gray result. You have a *subtractive* mixture. I shall return to this point later.

Cool off with Blue

Then we note warm and cool colors. I regret to say that the IES Handbook, that extraordinary Bible of the lighting profession, says: "The most popular association (of colors) consistently emphasized by artists is the *supposed* relationship of the red colors with warmth and the blue colors with lack of warmth. *This appears to have no foundation in fact.*" Really! I wonder if the author of that passage has cold blue walls in his living room or red-orange walls in his office. Two to one, he hasn't, and for just the reason which has "no foundation in fact." (Of course, he may be colorblind.) Anyway, people do react to some colors as "warm," or others as "cold," and don't let anyone tell you different. In a New York bank, where

air-conditioning could not be installed because of structural conditions and where summer heat was hard to bear, I replaced a tan wall and columns with a blue-green, light value wall, and white columns. Believe it or not, employees complimented me on the decreased heat.

As a matter of fact, our friend of the IES Handbook would not have been wrong had he said that the relationship of red colors to warmth and of blue colors to coolness occurs in the eye and mind, not in physics. It is the difference between physics on the one hand, and psychology on the other, that forces colorists to study the action of color on *both* the eye and the mind.

Before and After-Image

The human eye is a marvellous instrument, wonderfully accurate and adaptive in some respects, but possessing some peculiar habits. In the first place, it receives color impressions *in pairs* of complements, to which I have referred. It is so constructed that, when it tires of one color, it "sees" the complement of that color. After concentrating on red, it sees green; after orange, blue; and so on. Hence the phenomenon is called *after-image*. I used this peculiarity of the eye in the New York World's Fair at the exit from the Long Island Railroad Station where the first portion of the Fair to meet the eye of the visitor was a "Golden Circle." To accentuate the effect of the yellow and orange colors in that Circle, I glazed the strip windows of the long station with translucent blue-violet. By the time the visitor had walked its length, his eyes were tired of blue-violet and he was ready to see yellow-orange on anything. Consequently, he saw yellow *upon* yellow, and the comments ranged from: "My God, Emma, ain't that somp'n?" to "By George, old fellow, what an effect!"

I used the phenomenon in reverse for a recent job in a New York restaurant on 57th Street where I have a midnight blue rear dining room, lit only by pinhole spots from the ceiling and some spill. What did I make the anteroom? Bright warm yellow, of course. You should see the couples glide into that moonlit atmosphere made doubly blue by *after-image*, to hold hands and boost the profits of the management.

The second visual peculiarity to which I wish to draw attention is *simultaneous contrast*. This means that the eye never sees one color alone, except under laboratory conditions, but always in juxtaposition with other colors. Also, each color affects, and is affected by, adjacent colors. Each tends to throw a tinge of its complement upon the colors nearby. A green hat makes your lady's face more rosy; a red hat brings out the greenish or sallow hues. White, black, or gray, being neutral, have no hue effect. However, the white deepens the value of face colors, — makes her look more tanned, — and black forces her face towards an interesting paleness. Try these ideas on Her when She next asks your opinion of a hat, and astonish her.

Thirdly, notwithstanding the Handbook, the eye does credit the hues from yellow-orange to red with "feeling" warm and advancing, those from green to violet with "feeling" cool and retreating. Yellow-green and red-violet stay put in space. You are accustomed to seeing warm colors used to shorten up a long room, or cool colors to enlarge a small one, but have you thought of the ideal colors to hold a plane, visually where it actually is in space? A colleague of mine tells me that he studied the cloth of pool tables with the idea of finding out what color would remove the pool-hall curse from a table to be sold for home use. He found out that, visually, green never was the right color for that cloth. The balls with their bright colors stood above the retreating color. It was difficult for the eye to focus simultaneously on both balls and cloth. His solution was a grayed red-violet which offers a constant plane, neither receding nor advancing.

So much for the three principal visual phenomena: *simultaneous contrast*, *after-image*, and *advancing and retreating* (or *warm* and *cool*) colors. Their effect is due to the construction of the eye. Now, there are some human ideas about color which we should note and which occur in the brain, not in the eye. Call them psychological aspects of color, if you wish, though the term is none too accurate.

It is evident that *yellow*, color of sunlight, brings good cheer. Try painting a basement room in sunlight yellow and lighting it with incandescents some day, and see the spirits of people who work there rise accordingly. *Green*, which recalls foliage, has little effect upon human emotions and hence is relaxing because it demands no response. If you are picking a wife, you could do worse than choose one who loves green. She will be tolerant, liberal, rather conventional, well-balanced. Of course, she may not be much fun, either. *Blue* is definitely calming; it is used in paint and light for therapeutic purposes to quiet excitable patients. In deep, grayed values, it is a fine color for study halls, libraries, and such interiors where quietness and concentration are desirable. *Purple*, of course, is depressing. *Red* is exciting and holds a strong attraction for all mankind. It is no coincidence that *Life* and *Time* magazines have spots of strong red on their covers. At Madison Square Garden the programs used to be about the same red as is used on *Time*. Under bad advice, the management

thought money could be saved by using black and white. Immediately sales fell off, and they had to go back to red. *Orange* is the most exciting color of all. It is the color for extroverts and for getting recognition. The lady who is going to attend a large social function and wishes to be the center of attraction will wear a flaming orange dress.

Don't forget that every tint, shade, and tone of the six hues I have mentioned, and of the six intermediate ones, has its own particular psychological appeal. I mean that, within the parent hue of red, the pink, rose, normal red, and maroon will differ in effect, though their basic wave length is the same. You need not learn rules for such effects; all I suggest is that you consider all the possibilities before making up your mind what color is most appropriate in a given situation. To get an idea of the range of color, one of the scientifically arranged systems of classification is valuable. The following are all useful, though differing in detail:

1—The Munsell System, originated by A. H. Munsell.

2—Custom Color and the Color Coordinator, produced by the Martin Senour Company, organized by Fred Rahr and scientifically coordinated by Carl Foss.

3—The Color Harmony Manual produced by Container Corporation, organized by Egbert Jacobson and Walter Granville, and the scientific work done by Carl Foss, based upon Ostwald.

4—The Plochère System, originated by G. Plochère of Los Angeles.

Any one of these will help the person who wants to go beyond the A.B.C.'s of color.

Doing the Job Together

At this point, our converging paths have joined and I should like to present a few thoughts on how we could help each other if we were engaged on the same job.

First, it is obvious that level of illumination directly affects my colors upon which your light falls; the more light, the higher the apparent value of the color; the less light, the less its intensity, or saturation. With the present trend toward stronger lighting for better seeing, there is a possibility that the color which I desire for reasons mentioned above may be burned up by your strong light. Also, compromise may be necessary between the reflectances you desire for greater efficiency and a lesser reflectance which I might wish for decoration. At the present time, the trend in domestic architecture is away from pale tints and toward deeper values and bolder intensities for every room in the house. In the near future you may have to light living-rooms which have deep yellow-green or green-blue walls, much grayed; bedrooms in clear yellow or deep cool colors; bathrooms and kitchens in strong, bright, fresh colors. To indicate a way of handling these problems correctly, let me bring up the matter of absorption to which I said I would return.

We must remember that the color of any object depends upon its properties of absorbing certain rays of the spectrum of the light which falls upon it, and of reflecting other rays to the eye of the observer. So color in objects—such as marble, paint, draperies, furniture, rugs, and the like—is *subtractive*, whereas color in light is *additive*. One colored light thrown upon another *adds* the rays of one to the rays of the other. Now, unless the light which you throw upon my surfaces contains rays which my materials can reflect, the result is terrible. If I have a peach-colored wall in a restaurant and you install daylight fluorescent lamps, where do I get the yellow, orange, and red rays to be reflected by my peach color? If I want a strong blue wall, let me have the daylight; if red is what I am headed for, try the new "warmtone." The conclusion simply is that lighting expert and color expert must get together, discuss their problems, and reach a mutual adjustment *before* the client ever hears about it. In one case my client *did* hear about it first. In a Corn Exchange Bank branch in New York I had used a warm plum color wall for its welcoming effect, which was what the Bank wanted. The lighting man put in daylight lamps without conferring with me. Next day, when I arrived, the manager said: "What's the trouble here? Everybody looks sick." It didn't take long for me to find the difficulty and to ask for some pink tubes and some soft whites to remedy the matter, but it never should have gotten as far as the manager.

A second thought I should like to emphasize is that your light does not come from its source, strike a surface and just lie there. It bounces around like a tennis ball from one surface to another, leaving some of its energy at each point of contact, but also picking up a certain amount of hue from that contact. Thus the final light may be more saturated with color than when it started out. This accounts for the fact that a wall paper or paint may seem deeper and richer when applied to the room than in the small sample. There's nothing to be done about this except to call it to the decorator's or client's attention and get credit for free service, and for being a smart fellow.

A third point upon which we ought to be in agreement, but sometimes are not, is the effect upon architecture of the source of your light. Here I may be rushing in where an angel would fear to tread. I will refer first to the design of electric fixtures. Glance through the illustrations in Section 10, or in the back pages of the IES Handbook, or in any fixture catalogue. Where else can you find such

awkward, ill-proportioned, inartistic shapes as you find there? Even the most modern, up-to-date method of transforming energy into light, the fluorescent tube, is housed in a luminaire that looks as though it had been designed by General Grant. Here is a weak point in your armor, gentlemen. Get some real designers, or give your good designers their heads. Have a nation-wide competition with generous prizes. Do anything that will give us better-looking fixtures in stock lines.

Aside from fixtures as such, you will want to consider the architectural effect of your light sources. Take indirect lighting, for instance. Its effect is diametrically opposite to the architect's conception, unless he has designed with indirect lighting specifically in mind. Why is this? Because the ceiling is normally a covering, an enclosure above a given space which defines that space on the top side. Normally, light will enter below that lid, and it does so in daytime. When indirect lighting is turned on, the surface which receives least light in daylight suddenly becomes the brightest area in the room. I do not include in this objection the new fully luminous ceiling composed of egg-crates which baffle the sources above them. Here the mental transference seems to be that one has moved under a man-made sky and it is accepted, whereas the impression which I, for one, have in a room lighted indirectly by reflection from the ceiling is of being at the bottom of a well, looking upward to an unattainable world where light is. It makes me uncomfortable because it seems unnatural. I don't expect to get anywhere with this line of argument but I feel better in getting it off my mind.

I am also against cornices used as light sources, because they cut a room in half. However, I accept a coved ceiling which reflects light from concealed sources; again a simulation of the sky, I suppose, when carefully designed for the purpose.

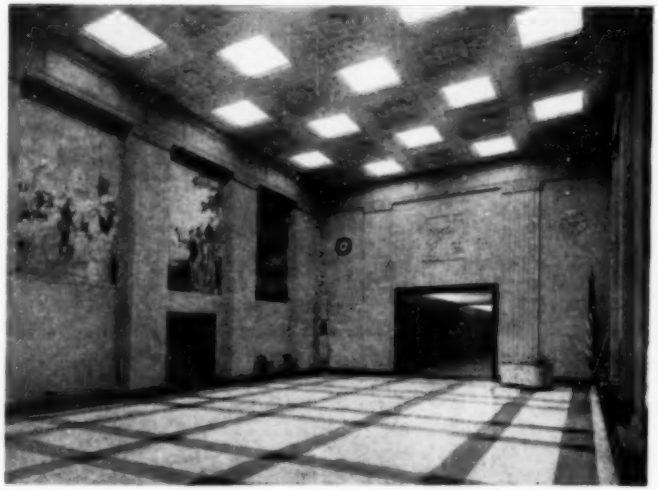
What You Can Do for Us

In closing, I have three requests to make of the lighting industry, on behalf of the designer, the decorator, and the user:

First, please give me a ceiling spot-light for emphasizing merchandise that does not create the strongest brightness-contrast in the whole interior between itself and the ceiling. I want the merchandise to be seen first, not the pattern of spots on the ceiling.

Secondly, I want a fluorescent tube which will give me a wave-length distribution approximating that of a tungstenfilament incandescent, which is still the most flattering light for human beings. I know that many bright fellows are working toward this end. Will they please hurry up!

Thirdly, as a vital part of your constructive campaign for "*Planned* Lighting," for better seeing, let me urge you also to plan for "better being seen." Plan to make the ladies pretty and the men handsome, so that every home, office, shop, factory, and store, is a more delightful place to live in. Plan for beauty!



Recessed glass-covered troffers using 4500K fluorescent lamps effectively light the entrance to this lobby of the New England Mutual Life Insurance Co., Boston, Mass. Architects from the Cram & Ferguson Company, and engineers of the Hixon Electric Co. of Boston, cooperated in the pleasing design. Photo courtesy Boston Edison Company through Electric Institute of Boston, Inc.

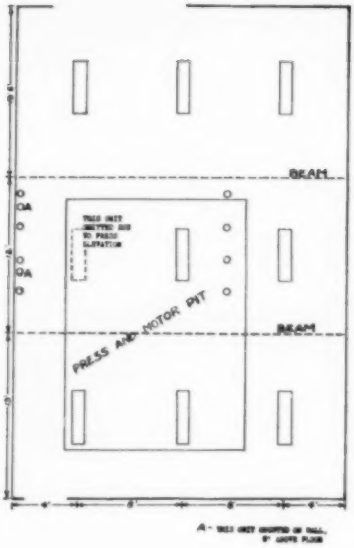
Lighting a Printing Press

LIGHTING OBJECTIVE: To provide illumination for the operations of a newspaper press.

Installation at the South Bay Daily Breeze, 131 South Pacific Avenue, Redondo Beach, California

(over)

A.I.A. File No. 31 / 13



General Information: The room is 38' by 24' by 11', with a flat white ceiling and pastel green walls.

Installation: Eight 3-lamp 40-watt fluorescent units (DayBrite Paralume #8348B) and ten 200-watt medium beam floodlamps (S&M #852L) are installed as indicated in the plan. This provides maintained general illumination of 30 footcandles with 60-100 (adjustable) on the working area. Paralumes were chosen rather than the industrial fluorescent units generally used for such installations in order to obtain reduced brightness ratios between ceiling and luminaire; the floodlamp incandescent units are easier to maintain under the ink conditions than the more conventional fluorescent industrial units mounted on a 45-degree angle.

Brightnesses are indicated below:

Ceiling	120	footlamberts
Luminaires (fluorescent)	2400	"
Walls	20	"
Paper in press	120	"
Desk used for inspection	20	"
Newsprint as it is inspected after it leaves the press	60	"

None of the lighting units is in the line of vision during press operations or inspection.

Lighting designed by F. J. Rohring, installed by Christmas Electric Company. Lighting data submitted by F. J. Rohring, South California Edison Company, Redondo Beach, California, as an illustration of good lighting practice and to aid in the design of similar installations.

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Lighting is a World-Wide Interest

By ARTHUR A. BRAINERD

SCIENTIFIC KNOWLEDGE is no respecter of national boundaries. The manner in which the characteristic national skills tend to complement each other is well illustrated by an incident which occurred at the meetings of the International Commission on Illumination in Holland in 1939. Mr. Conway, representing the United States, read a paper prepared by R. B. Brown, on the I.E.S. Certified Lamp Activity. When the paper was opened for discussion, Dr. N. A. Halbertsma from Holland, president of the Commission, arose and pointed to what was apparently an I.E.S. Study Lamp: "There is the first I.E.S. Study Lamp. It was made in Holland in 1918. But you have taken it to the public. If we in Holland had done as good a job of education as you have, we would have sold 400,000 instead of a mere 4,000. I salute U.S.A." The International Commission does not in any way compete with the I.E.S., but rather supplements it, by encouraging international exchanges of ideas; from it we bring home new and valuable information and through it we explain our viewpoints to Europeans and others. The need for an international lighting organization is just as apparent as is the need for a national society.

The first meeting of the Commission was held in Berlin in 1913, when it superseded the International Commission on Photometry, which was founded in 1900 and which had solved some important problems concerning the gas lighting industry and had put forth the International Candlepower Standard.

Throughout the history of the Commission, the organization has been fortunate in having the very highest type of leadership, both at the national and international level. Without exception, the leaders of the United States National Committee have been high in the councils of the I.E.S. The present executive subcommittee of six includes three past-presidents of the Society. Moreover, because of its primary concern and interest, the I.E.S. is allotted three times as many members on the United States National Committee as any other organization.

There is an old saying that any successful institution is the lengthened shadow of a man. If this be true, Sir Clifford Paterson, O.B.E., was that man in the International Commission on Illumination. His was the guiding genius that brought about its formation. He functioned as honorary secretary from the time of its inception until his death in 1948, two days after receiving the I.E.S. Gold medal, except for one three-year term as president.

In order to appreciate the significance and work of the International Commission on Illumination, it should be considered in its relation to the whole international field of science and engineering. In common with dozens of similar international bodies, men from many nations are brought in contact to pool their information on an important branch of engineering in which they have a common interest — Light and Seeing.

Functionally, the ICI is built around a Central Bureau which is the administrative headquarters. International relationships and representation are the responsibility of a group of national committees, each representing a member nation. The technical work of the Commission is carried on by a group of technical committees. The officers consist of a president, three vice-presidents, an honorary treasurer, and an honorary secretary who presides over the Central Bureau. The normal term of service is for three years, or from one international session to the next. The detail work is handled by a Secretary General. An Executive Committee consists of two representatives from each of the member nations. Theirs is the task of formulating policies and organizing the business for presentation at plenary sessions.

Each of the member nations may organize its own national committee in any way that it sees fit so long as it is truly representative of the country. The United States National Committee is composed of from 40 to 50 members including: (1) representatives of National technical societies; (2) representatives or secretariat-directors on ICI technical committees; (3) delegates to the latest international meetings; (4) members-at-large. At present the committee's income is contributed by its five sustaining members: The Illuminating Engineering Society; the American Institute of Electrical Engineers; the Association of Edison Illuminating Companies; the Optical Society of America; and the Society of Motion Picture Engineers. I.E.S. has nine voting representatives on the committee and each of the other sustaining members has three.

This article presents the essential substance of an address given at the I.E.S. East Central Regional Conference at Harrisburg, Pa., June 6-7, 1949. The author, in addition to his duties as illuminating engineer, Market Studies and Service Div., Philadelphia Electric Co., is giving active service as President of the United States National Committee of the International Commission on Illumination.

The work of the commission is carried on through some 25 technical committees: These committees normally are established at a plenary session, usually at the suggestion of a member nation, although they can be established between sessions by the Central Bureau, working through the executive committee. One nation is assigned the secretariat, and each national committee has the privilege of appointing one representative.

The first international meeting of the ICI after succeeding the International Photometric Commission in 1913 was held in Paris in 1921. Since then, in addition to some informal meetings, six plenary sessions have been held: 1924, Geneva; 1928, Saranac; 1931, Cambridge; 1935, Karlsruhe; 1939, Scheveningen; and 1948, Paris. The constitution calls for international meetings every three years, but war has interfered.

Gradually the ICI has evolved from an international standardizing body to an international body in which legislation plays a very minor part. The various experts from each country compare views by correspondence and meet and discuss progress in the art at the triennial meeting. In many cases recommendations are adopted. Observance of these recommendations is not mandatory, although they may become international standards when adopted by a suitable body such as the International Organization for Standardization.

Perhaps the best way to present the accomplishments of the International Commission on Illumination is to quote President Halbertsma in an address to the British I.E.S., May 13, 1947.

> The primary unit of light and the progress of its realization by the blackbody as a fundamental standard have come up at all sessions of the ICI, but when in 1931 the Bureau International des Poids et Mesures included in its programme the unit of light, the ICI, through a special committee including delegates of the four large national physical laboratories, kept in touch with the BIPM, for this body by its authority could introduce the New Candle officially, whereas the ICI could only have made a recommendation to the national committee.
>
> Automobile lighting has also been an item which has continuously been dealt with by the ICI. . . . After 1931 such a rapid development of civil aviation occurred that the Conference Internationale Aerienne was very glad to accept the results of the work of the ICI . . . as the basis for its recommendations to the Conference Internationale pour la Navigation Aerienne. To accelerate this work, the ICI committee on aviation Lighting held an intermediate meeting in Zurich in 1932.
>
> In 1924, the ICI agreed upon a table of provisional values for the relative luminosity factor, which has since been incorporated in the Vocabulary issued by the ICI in 1939. This Vocabulary is more than a list, it is a technical dictionary which contains 95 terms used in illuminating engineering, given in four languages . . . enhanced by the fact that it contains full definitions in addition to the terms. A more extensive list, giving for 850 terms the equivalent expressions in Dutch, German English, French, and Esperanto, has been prepared by the Dutch National Committee. Its second edition appeared in 1941.
>
> As a last example of the work of the ICI, I would like to mention the recommendations on standard conditions for colorimetry, which are based on the excellent work of the British committee, and which led to the ICI trichromatic colorimetric system.

In all of these examples cited by President Halbertsma, and especially in the development of the blackbody standard of light, automobile lighting, and the ICI trichromatic colorimetric system, the United States played a major role.

At the 1948 Paris Sessions, the Central Bureau was transferred to the United States. C. A. Atherton was elected honorary secretary, and Raymond Whitney was appointed to the position of secretary general. Headquarters were established at 8 East End Avenue at 79th Street in New York City. At present the Bureau has no paid employees and pays no rent. Prior to this transfer, the Bureau had been maintained at the National Physical Laboratories, Teddington, England.

One of the first actions of the new honorary secretary was to institute a series of Quarterly Letters to all national committees, to promote an international exchange of information on developments in the art and science of illumination while it is still news. An effort also is being made to spread the work of preparation for the 1951 international meeting more evenly over the intervening time. By this method it is hoped to establish the work of each national committee as a continuing operation. While the other national committees contribute much time and thought to the work of the International Commission, the initiative and responsibility rests largely with the country which is the seat of the Central Bureau.

Now the time is ripe to develop a genuine world-wide lighting organization which will accomplish the same sort of result that is secured here in the United States through the Illuminating Engineering Society. Through the medium of the International Commission we are extending our knowledge of the art and science of illumination. This exchange of knowledge is a two-way street. Only by a free exchange of technical knowledge throughout the civilized world can we hope to achieve the highest possible standard of excellence in any branch of engineering. On this basis alone, it deserves the increasing support of the Illuminating Engineering Society and its members. But, above and beyond this objective, we are doing our part to build a permanent peace when we help to establish a close personal acquaintanceship and working understanding across the seas.

Luminous-Ceiling Lighting

By PARRY MOON
DOMINA EBERLE SPENCER

The paper deals with the design of complete luminous ceilings lighted from above. Such lighting compares favorably in coefficient of utilization with other methods and has definite advantages over the louverall ceiling. For brightness uniformity, the normal spacing between rows of fluorescent lamps should not exceed twice the distance between lamps and translucent plates. Also, the outside rows of lamps should be spaced three quarters of normal spacing, and the distance from them to the sides of the lightbox should be one-quarter of normal spacing rather than the one-half generally used in the past.

ILLUMINATING engineers are becoming increasingly conscious of the necessity for planned lighting that will provide ideal visual conditions. As a step in this direction the I.E.S. Committee on Standards of Quantity and Quality of Interior Illumination[1] has recommended a 3:1 brightness (helios) ratio* for all rooms in which the visual task is severe. The recently developed interflection method[2] allows the brightness (helios) ratios to be predetermined for any room and gives a foundation for the design of really satisfactory lighting installations. A previous paper[3] presented a series of charts showing under what conditions the 3:1 ratio can be satisfied. Exposed fluorescent lamps give a brightness (helios) ratio of 50:1 or more** and therefore should not be used in offices, drafting rooms, school rooms, or other places where close visual work is encountered. The same brightness (helios) ratio is obtained with louvered fixtures and with the louverall ceiling, which are therefore potential sources of reflected glare.

Ideal lighting is thus narrowed down to two possibilities:

1. Ceiling lighting, Type IIb, where the entire ceiling acts as a secondary source.[4] The only satisfactory hanging luminaire for this type of lighting is of the luminous indirect type, the bottom of the luminaire having approximately the same brightness (helios) as the ceiling.

2. Luminous-ceiling lighting, Type IIa, utilizing a hung ceiling of translucent plastic or other diffusing material lighted from above.

Even with IIa and IIb lighting, the 3:1 criterion is satisfied only if high enough reflectances are used. With a floor reflectance of 0.10, the interflection method (Fig. 1a) shows that the 3:1 ratio is never satisfied, though a ratio of less than 10:1 is usually obtained. By raising the floor reflectance to 0.30 and employing a wall reflectance of at least 0.50, however, one obtains excellent visual conditions (Fig. 1b), at the same time utilizing the light most economically.[5]

Type IIb lighting is employed in many installations today, though generally with such low reflectances that the potential excellence of the lighting system is obscured. Luminous-ceiling lighting (IIa) offers interesting possibilities and merits further study. The purpose of the present paper is to begin such a study by investigating the design of luminous ceilings.

Fig. 2 shows one arrangement for ceiling lighting. Continuous rows of fluorescent lamps are attached to the ceiling. No reflectors are employed and the ceiling is painted white. At distance l below the lamps is a grid of metal bars. Since the grid supports only a small weight and is hung from the ceiling at frequent intervals, it can be of very light construction. Resting on the grid are flat panels of diffusing plastic which can be slid to the side or removed for relamping and cleaning. A less-expensive construction employs, in place of each plastic panel, a simple frame covered with thin diffusing plastic, tracing paper, or glass cloth. Convenient dimensions are $s = 0.6$m (24 in.), $l =$

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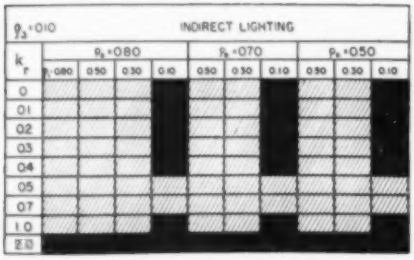
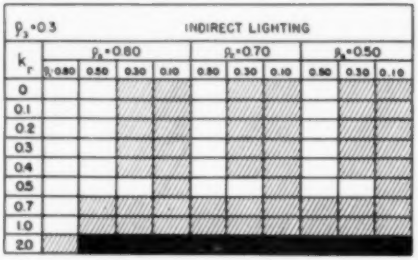
*The 3:1 ratio does not mean that the maximum brightness (helios) in the room is limited to 3 times the minimum. It does mean that the adaptation brightness (helios), for any orientation of the eyes, must not exceed 3 times the adaptation brightness H for the work; and the adaptation brightness of the work must not exceed 3 times the minimum adaptation brightness for any orientation of the eyes. Since the adaptation brightness associated with an extended surface is essentially equal to the brightness of the surface, one may express the criterion as

$$H_{max}/H_A < 3,$$

$$H_A/H_{min} < 3.$$

**The 40-watt T-12, 3500K white fluorescent lamp has a brightness (helios) of 18,000 blondel and the 96-in., T-8, 4500K white lamp has approximately the same brightness (helios). But this value is so much greater than any other brightness (helios) in the room that poor visual conditions are sure to result if louvered fixtures are used. A high value of illumination (incident pharosage) is 500 lumen m^{-2} (47 lumen ft^{-2}); and with ordinary printed matter having an average reflectance of 0.65, the eyes will adapt to the brightness (helios) $H_A = 500 \times 0.65 = 325$ blondel. Thus the brightness (helios) ratio is $H_{max}/H_A = 18000/325 = 55$.





Figures 1a and 1b. Charts for ceiling lighting, showing in what cases the 3:1 brightness (helios) ratio can be obtained. Blank areas indicate that adaptation brightness (helios) ratios for ceiling, walls, and floor are less than 3:1. Cross-hatched areas show that the highest ratio is more than 3 but less than 10. Black areas indicate a maximum brightness (helios) ratio of more than 10. Wall reflectance is denoted by ρ_1, ceiling reflectance by ρ_2, and floor reflectance by ρ_3. Domance k_r specifies the shape of the room and is evaluated by means of the equation,

$$k_r = S_1/4S$$

where S_1 is the total wall area and S is the floor area.

0.3m (12 in.). The individual panels can be approximately 0.6 x 0.6m (24 x 24 in.). The appearance of a room lighted by this type of construction is indicated in Fig. 3.

Design

For any type of lighting, the average illumination (pharosage) is expressed by the well-known equation,

$$D_{AV} = k_u \frac{F_L}{S} = fg \frac{F_L}{S}$$

where D_{AV} = average incident illumination (pharosage) (lumen m^{-2}) on principal surface,
k_u = coefficient of utilization,
F_L = total lumen (pharos) from lamps,
S = floor area (m^2),
f = interflectance of room,
g = efficiency (logance) of luminaire.

For simplicity, we shall consider only rooms that are so large ($k_r \rightarrow 0$) that the effect of the walls may be neglected. Further analysis[6] shows that the *general conclusions* obtained in this limiting case apply to all rooms though numerical values may vary somewhat. For an infinite room lighted by a luminous ceiling,

$$f = \frac{1}{1 - \rho_2' \rho_3}. \qquad (2)$$

Thus from Equation (1),

$$D_{AV} = \frac{g}{1 - \rho_2' \rho_3} \frac{F_L}{S}. \qquad (3)$$

Also, the brightness (helios) of ceiling and floor are

$$H_2 = \frac{g F_L}{(1 - \rho_2' \rho_3) S} \qquad (4)$$

$$H_3 = \frac{\rho_3 g F_L}{(1 - \rho_2' \rho_3) S} \qquad (5)$$

where ρ_2' = apparent reflectance of luminous ceiling, as viewed from below,
ρ_3 = reflectance of floor,
H_2 = average brightness (blondel) of luminous ceiling, as viewed from below,
H_3 = average brightness (blondel) of floor.

Equations (2) to (5) were obtained by mentally following the light as it bounces about between floor and ceiling.[7] The interflections in the luminaire (upper portion of the room, including translucent plates, Fig 4) were not considered specifically. We now bring the luminaire into the picture and find how its characteristics change as the reflectance and transmittance are altered. The equation for D_{AV}, derived in Appendix A of the present paper, is

$$D_{AV} = \frac{\tau(1 + \rho_3)}{2(1 - \rho_2 \rho_3)} \frac{1}{1 - \rho_3 \left[\rho_2 + \dfrac{\rho_2 \tau^2}{1 - \rho_2 \rho_3} \right]} \frac{F_L}{S}. \qquad (6)$$

Here τ = transmittance of translucent plates,
ρ_2 = reflectance of translucent plates,
ρ_3 = reflectance of ceiling (See Fig. 4).

Comparison of equations (3) and (6) shows that the efficiency (logance) of the luminaire is

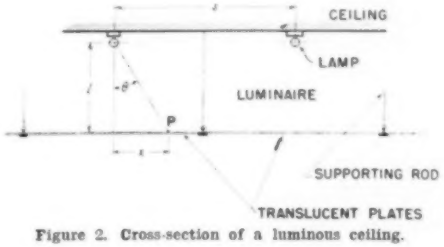


Figure 2. Cross-section of a luminous ceiling.

Figure 3. Appearance of a room lighted by means of a luminous ceiling (Type IIa lighting).

$$g = \frac{\tau\,(1 + \rho_5)}{2\,(1 - \rho_2\,\rho_5)} \qquad (7)$$

and the apparent reflectance of the luminous ceiling, as seen from below, is

$$\rho_2' = \rho_2 + \frac{\rho_5\,\tau^2}{1 - \rho_2\,\rho_5}. \qquad (8)$$

Equation (7) shows that the efficiency (logance) increases as the transmittance of the translucent plates is increased and depends also on the reflectances of the luminaire surfaces. Equation (8) indicates that the apparent reflectance of the ceiling, as seen from below, is equal to the true reflectance ρ_2 of the translucent plates plus a term that includes luminaire reflectances and transmittance.

Equations (7) and (8), in conjunction with equations (2) to (5), give complete information for the design of luminous ceilings. If $k_r \to 0$, the average illumination (pharosage) is given by equation (3) and the values of brightness (helios) by equations (4) and (5), where g and ρ_2' are obtained from equations (7) and (8). If $k_r \to 0$, equations (7) and (8) still give approximate values of efficiency (logance) and apparent reflectance which can be used in the interflection tables.[8]

Fig. 5 shows how the apparent reflectance of the translucent plates varies as the transmittance is varied. The assumption is made that

$$\rho_2 = 0.90 - \tau,$$

which agrees with experimental data on the best translucent materials.[9] The curves were calculated by use of equation (8). If the ceiling were black ($\rho_5 = 0$), the apparent reflectance ρ_2' would be the same as the reflectance ρ_2 of the translucent plate. When the ceiling is painted white, however, the apparent reflectance rises. For $\tau = 0.50$, the apparent reflectance is not equal to $\rho_2 = 0.40$ but

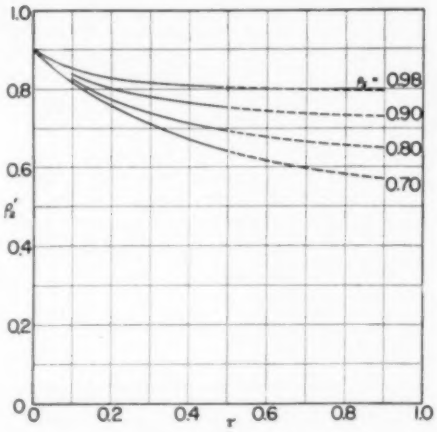


Figure 5. Apparent reflectance of the luminous ceiling, as a function of the transmittance τ of the translucent plates and of the reflectance ρ_5 of the surface above the lamps.

varies from 0.65 to 0.80 depending on the reflectance ρ_5.

The efficiency (logance) of the luminaire is plotted in Fig. 6. The curves show again that the reflectance ρ_5 should be as high as possible. They also indicate that the transmittance of the translucent plates should be as high as is consistent with good diffusion.

Fig. 7 gives the coefficient of utilization for a room with ceiling lighting and having a floor reflectance of 0.30 and a k_r of zero. Note that a coefficient of utilization of 0.80 is easily obtainable,*

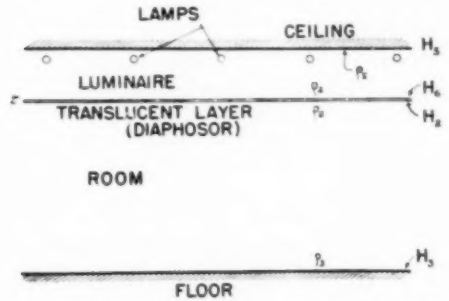


Figure 4. Cross-section of a room lighted by a luminous ceiling.

*Note that these values of k_r are for an infinite room. For other rooms, the coefficient of utilization is lower and can be obtained from the interflection tables, Reference 3.

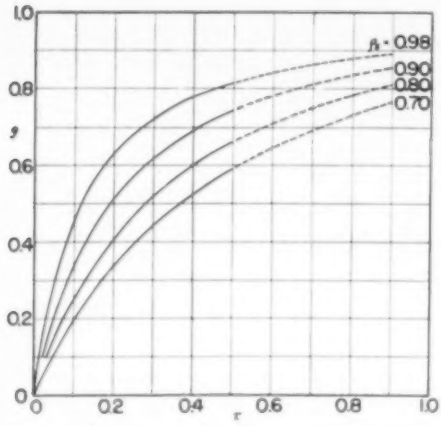


Figure 6. "Efficiency" (logance) of a luminous ceiling.

and values of more than 1.00 are possible by raising the reflectances ρ_3 and ρ_5. Thus luminous-ceiling lighting compares favorably with any other form of lighting in effectiveness. One might think that the louverall ceiling, being a "direct" lighting system, would have a higher coefficient of utilization than the luminous ceiling, but such is not the case. With a 45° cut-off, each cell of the louverall ceiling acts like a miniature cubical room interposed between the lamps and the large room. And lighting in a cubical room is always inefficient[8]. This fact accounts for the low values of k_u (0.25 to 0.40 according to C. L. Amick[10]) obtained experimentally on louverall installations.

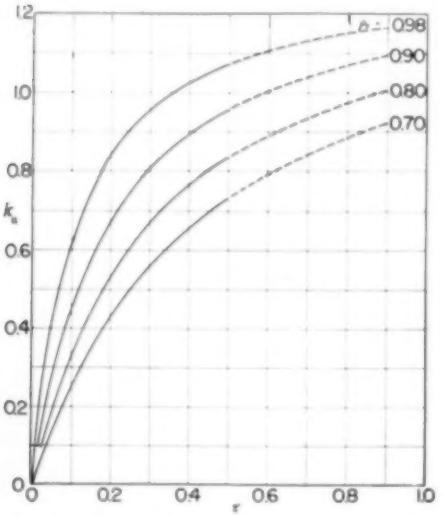


Figure 7. Coefficient of utilization of an infinite room with IIa lighting, $k_r = 0$, $\rho_3 = 0.30$.

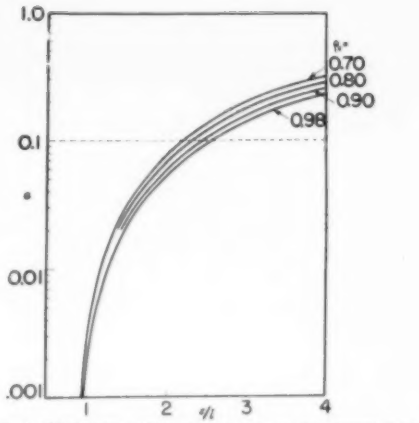


Figure 8. Brightness (helios) variation of the translucent plates for an infinite luminous ceiling, as affected by the lamp spacing s and the distance l between lamps and translucent plates. The contrast c is

$$c = \frac{H_{max} - H_{min}}{H_{max}}.$$

The horizontal line at $c = 0.10$ represents the minimum perceptible variation. Thus spacings of approximately $2l$ will give a ceiling that appears to be uniform.

Spacing of Lamps

Consider now the spacing between rows of lamps that will give visual uniformity for the luminous ceiling. Since the translucent plates are assumed to be perfectly diffusing, uniformity in brightness (helios) requires merely that the incident pharosage (including interflections) on the top of the plates be uniform. Appendix B gives equations for the maximum and minimum incident pharosage and for the contrast:

$$c = \frac{H_{max} - H_{min}}{H_{max}} = \frac{D_{max} - D_{min}}{D_{max}}.$$

The results are plotted in Fig. 8, which shows how c increases when the spacing between lamps is increased. The analysis includes the direct light from the lamps and the infinite number of interflections within the luminaire. According to W. E. K. Middleton,[11] a contrast of 0.10 is just detectable in a gradual transition from one brightness to another. Using this criterion, we see that a spacing of $2l$ between rows of lamps is allowable. That is, in a very large room, *the spacing between rows of fluorescent lamps may be made twice the distance from the lamps to the translucent plates.* This rule presupposes a diffusing upper surface with high reflectance ρ_5.

TABLE I — Dimensions for Luminous-Ceiling Lighting
with normal spacing of $s = 0.61$m (24"), $l \geq 0.30$m (12").

Width of available space (w)		Number rows (n)	Spacing of outside rows $= \frac{3}{4}\ s$		Distance to sides of luminaire $= \frac{1}{4}\ s$	
(meter)	(ft)		(m)	(in.)	(m)	(in.)
0.91	3	2	.....	.....	0.15	6.0
1.52	5	3	.....	.....	0.15	6.0
1.83	6	4	0.46	18	0.15	6.0
2.44	8	5	0.46	18	0.15	6.0
3.05	10	6	0.46	18	0.15	6.0
3.66	12	7	0.46	18	0.15	6.0
4.27	14	8	0.46	18	0.15	6.0
4.88	16	9	0.46	18	0.15	6.0
5.49	18	10	0.46	18	0.15	6.0
6.10	20	11	0.46	18	0.15	6.0

For other spacings, change all dimensions in proportion. The total width is

$w = (n - \frac{1}{2})s$ for $n = 2$ or 3.

$w = (n - 1)s$ for $n \geq 4$.

The distance from lamp to panel is

$l \geq s/2$.

The above study of lamp spacing has been for an infinite room. There still remains the question of lamp spacing at the sides of the room. Should the lamp spacing remain uniform throughout or should there be a reduction in spacing near the sides of the room? Also, what spacing should be employed between the final row of lamps and the side of the luminaire? The equations are given in Appendix C.

For a narrow panel containing only two rows of lamps, the illumination (pharosage) without interflections is easily calculated. The results are shown in Fig. 9 for spacings of 1.5, 2, and 3 times the distance l. The spacing $s = 2l$ gives approximately 20 per cent variation without interflections, but this value is reduced to about 10 per cent by multiple reflections. The graph shows also that to keep the edges of the translucent plate at sufficiently high helios, *the distance between lamp and end of luminaire must be approximately one-fourth of the normal spacing between lamps.* Similar conclusions apply to 3, 5, and 7 rows of lamps. A trial-and-error process showed that when more than three rows are employed, *the outside rows should be moved toward the center so that their spacing is three-quarters of normal spacing.* This arrangement is found to give better uniformity than with normal spacing ($s = 2l$) throughout. An illumination (pharosage) plot for seven lamps spaced in this way is shown in Fig. 10.

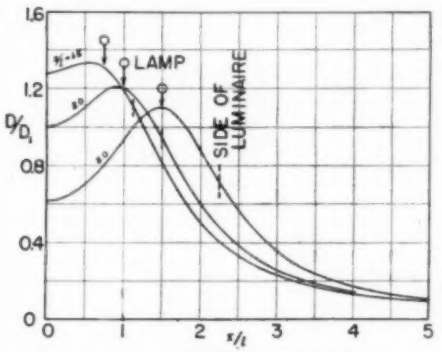


Figure 9. Incident illumination (pharosage) on translucent plate without interflections). Two infinitely long rows of fluoresent lamps. Brightness (helios) at the edge of plate is made approximately equal to brightness (helios) in the center ($x = 0$) by using ¼ normal spacing between lamps and sides of luminaire.

Conclusions

Equations and graphs have been given for the design of luminous ceilings. It is found that the coefficient of utilization compares favorably with the best values obtained with other lighting systems. In particular, the complete luminous ceiling costs no more than the louverall ceiling, has a higher coefficient of utilization, and eliminates that great defect of the louverall — *reflected glare.* Properly designed, the luminous ceiling gives ideal lighting that satisfies the 3:1 brightness (helios) criterion and all eight factors of lighting.[12]

Best results are obtained under the following conditions:

1. The translucent plates should have the highest transmittance that is consistent with complete diffusion. The optical absorptance of the material should be as low as possible.
2. The reflectance ρ_3 of the upper surface in the luminaire (Fig. 4) should be at least 0.80.
3. Floor reflectance ρ_5 in the room should be at least 0.30 and average wall reflectance should be at least 0.50.
4. The normal spacing s between rows of lamps should not exceed twice the distance l between lamp centers and translucent plates.
5. With more than 3 rows of lamps, the spacing of the outer rows should be three-quarters of normal spacing.

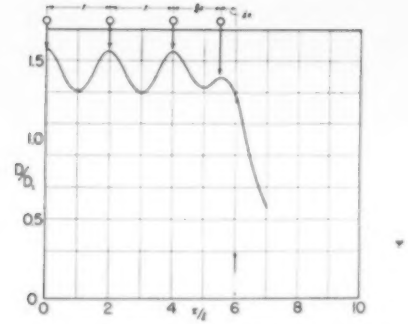


Figure 10. Incident illumination (pharosage) on translucent plate (without interflections). Seven infinitely long rows of fluoresent lamps.

6. Spacing between outside rows of lamps and side walls of the luminaire should be one-fourth of normal spacing between lamps. The old rule has been to use one-half normal spacing, but the present analysis shows that one-fourth is definitely superior.

7. Each row of lamps should run to the extreme end of the luminaire. In fact better brightness uniformity is obtained by making the length of the luminous panel slightly less than the total length of a row of lamps.

Some suggested dimensions are given in Fig. 11 and Table I. The table shows how many rows n of fluorescent lamps are needed for different available widths w. The tabulated values are for a normal spacing of 0.61m (24 in.), but dimensions for any other spacing are easily obtained. The spacing s is determined by the desired illumination (pharosage) D_{AV}, and Table II is included as an aid in determining this spacing. Values of D_{AV} have been calculated for various lamp spacings and for two rooms, one very large ($k_r \to 0$) and one of rather small size ($k_r = 0.70$). Most rooms will fall between these two extremes and may be investigated in greater detail by use of the interflection tables.[3] Table IIa gives the illumination (pharosage) in metric units and Table IIb gives the same data in English units.

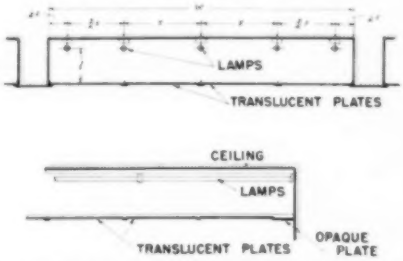


Figure 11. Portion of a luminous ceiling, showing how the spacing between lamps is reduced near the sides of the luminaire. The lower view indicates how the lamps extend beyond the end of the translucent plates to make the brightness (helios) more nearly uniform.

Lighting in accordance with the foregoing specifications has been installed in one room,[13] and other installations are in the process of construction. Tests indicate that the theoretical analysis is sound. There remain many questions of best ar-

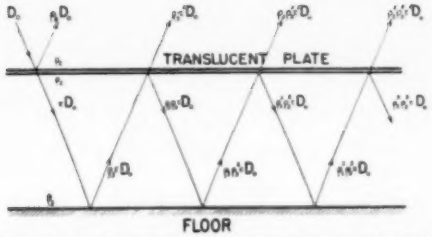
TABLE IIa — Average Illumination (Pharosage) as a Function of Lamp Spacing

Normal Spacing (s)		Average Illumination (Pharosage) (lumen m^{-2}) in Service					
		$k_r \to 0$			$k_r = 0.70$		
(m)	(in.)	*T*-12, 40w	*T*-8, 200 ma	*T*-8, 100 ma	*T*-12, 40w	*T*-8, 200 ma	*T*-8, 100 ma
0.30	12	4090	2710	1600	1790	1190	700
0.46	18	2730	1800	1070	1240	790	470
0.61	24	2040	1360	800	900	600	350
0.76	30	1640	1090	640	720	480	280
0.92	36	1370	900	530	600	400	230
1.22	48	1030	680	400	450	300	170

The lamps are the 40 watt, 48", *T* 12, 3500K white fluorescent lamp (2300 lumen), and the *T*-8, 96", 4500K white lamp operating at 200 ma (3050 lumen) and 100 ma (1800 lumen). Reflectances are $\rho_c = 0.30$, $\rho_f = 0.50$, $\rho_h = 0.80$. Also, $\tau = 0.40$, $k_u = 0.87$, $k_d = 0.76$ for $k_r \to 0$, $k_u = 0.333$ for $k_r = 0.70$.

TABLE IIb — Average Illumination (Pharosage) as a Function of Lamp Spacing

Normal Spacing (s)		Average Illumination (Pharosage) (lumen ft^{-2}) in Service					
		$k_r \to 0$			$k_r = 0.70$		
(m)	(in.)	*T*-12, 40w	*T*-8, 200 ma	*T*-8, 100 ma	*T*-12, 40w	*T*-8, 200 ma	*T*-8, 100 ma
0.30	12	380	250	150	170	110	65
0.46	18	250	170	100	110	74	44
0.61	24	190	130	74	84	55	33
0.76	30	150	100	60	67	44	26
0.92	36	130	84	50	55	37	22
1.22	48	95	63	37	42	28	16



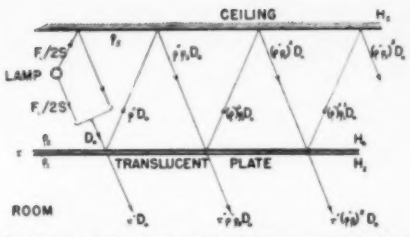


Figure 12. (Left). Schematic diagram showing interflections of light in an infinite room with arbitrary incident illumination (pharosage) D_0 applied to top of the translucent layer. The actual reflection and transmission is, of course, diffuse but is drawn schematically in one direction for simplicity in representation. The values are rigorously correct for infinite rooms with perfectly diffusing surfaces. Figure 13. (Right). Schematic diagram showing interflections in an infinite luminaire.

rangements for practicability and economy, and it is hoped that the present paper will stimulate further work in the development of ceiling lighting.

Appendix A

Interflections in an Infinite Room

Consider an infinite room (Fig. 4) lighted by means of a luminous ceiling. It is proposed to investigate the interflections in the complete assembly. All surfaces are assumed to be perfectly diffusing, and (F_L/S) is the total lamp lumens (pharos) per unit area of ceiling.

(I) First we formulate the interflections in the room itself, with arbitrary incident illumination (pharosage) D_0 on the top of the panel and no interflections in the luminaire. Fig. 12 gives a schematic diagram of the multiple reflections within the room. Adding all the components that go upward through the translucent plate, we obtain the brightness (helios) of the plate as seen from above:

$$H_6 = D_0\,[\rho_2 + \rho_2\tau^2(1 + \rho_2\rho_3 + \rho_2^2\rho_3^2 + \ldots]$$
$$= D_0\left[\rho_2 + \frac{\rho_2\tau^2}{1-\rho_2\rho_3}\right].$$

But $H_6/D_0 = \rho'' =$ apparent reflectance of plate, as seen from above. Thus when light is incident on the upper side of the translucent plate (or "diaphosor"), it is not reflected according to the usual reflectance ρ_2 of this plate but according to the enhanced reflectance,

$$\rho'' = \rho_2 + \frac{\rho_2\tau^2}{1-\rho_2\rho_3}. \tag{9}$$

The apparent reflectance ρ'' is higher than ρ_2 because of the light reflected within the room.

Similarly, the brightness (helios) of the translucent plate, as seen from below, is obtained by adding all the contributions (Fig. 12), or

$$H_2 = \tau D_0\,[1 + \rho_2\rho_3 + (\rho_2\rho_3)^2 + (\rho_2\rho_3)^3 + \ldots]$$
$$= \frac{\tau D_0}{1-\rho_2\rho_3}.$$

But $H_2/D_0 = \tau'' =$ apparent transmittance of ceiling, with no interflections within the luminaire. Thus,

$$\tau'' = \frac{\tau}{1-\rho_2\rho_3}. \tag{10}$$

The apparent transmittance of the diaphosor is higher than the measured transmittance τ because of multiple reflections within the room.

(II) The second step is to employ equations (9) and (10) in calculating the interflections in the luminaire (Fig. 13). Irrespective of where the fluorescent lamps are placed in the luminaire, exactly half of their luminous output is incident directly on the ceiling and half on the translucent plate. The total incident illumination (pharosage) without multiple reflections, is evidently

$$D_0 = \frac{F_L}{2S}(1+\rho_3).$$

Adding the components reflected upward (Fig. 13), we obtain

$$H_6 = D_0\rho''\,[1 + (\rho''\rho_3) + (\rho''\rho_3)^2 + \ldots]$$
$$= \frac{D_0\rho''}{1-\rho''\rho_3} = \frac{F_L(1+\rho_3)\rho''}{2S(1-\rho''\rho_3)}. \tag{11}$$

And the transmitted components give

$$H_2 = D_0\tau''\,[1 + (\rho''\rho_3) + (\rho''\rho_3)^2 + \ldots]$$
$$= \frac{D_0\tau''}{1-\rho''\rho_3} = \frac{F_L(1+\rho_3)\tau''}{2S(1-\rho''\rho_3)}. \tag{12}$$

Also,

$$H_3 = \frac{\rho_3 F_L}{2S} + \rho''\rho_3 D_0[1 + (\rho''\rho_3) + (\rho''\rho_3)^2 + \ldots]$$
$$= \frac{\rho_3 F_L}{2S}\left[1 + \frac{\rho''(1+\rho_3)}{1-\rho''\rho_3}\right]. \tag{13}$$

(III) We now obtain equations for coefficient of utilization, logance, and apparent reflectance of the complete luminous ceiling. Since the room is infinite in extent, the average illumination (pharosage) on the principal surface is

$$D_{AV} = H_2$$

or from equation (12),

$$D_{AV} = \frac{(1+\rho_3)\tau''}{2(1-\rho''\rho_3)}\frac{F_L}{S} = \frac{\tau(1+\rho_3)}{2(1-\rho_2\rho_3)}$$
$$\frac{1}{1-\rho_3\left[\rho_2 + \dfrac{\rho_3\tau^2}{1-\rho_2\rho_3}\right]}\frac{F_L}{S} \tag{14}$$
$$= \frac{\tau(1+\rho_3)}{2(1-\rho_2\rho_3)}\,\frac{1}{1-\rho_3\left[\rho_2 + \dfrac{\rho_3\tau^2}{1-\rho_2\rho_3}\right]}\frac{F_L}{S}.$$

But in any room,

$$D_{AV} = k_u\frac{F_L}{S}.$$

Thus the coefficient of utilization k_u for an infinite room with Type Ha lighting is

$$k_u = \frac{\tau(1+\rho_3)}{2(1-\rho_2\rho_3)} \cdot \frac{1}{1-\rho_3\left[\rho_2 + \dfrac{\rho_3\tau^2}{1-\rho_2\rho_3}\right]}$$

$$= \frac{\tau(1+\rho_3)}{2[(1-\rho_2\rho_3)(1-\rho_2\rho_3)-\rho_3\rho_3\tau^2]}. \qquad (15)$$

Comparison of equations (3) and (6) shows that the efficiency (logance) of the luminaire is

$$g = \frac{\tau(1+\rho_3)}{2(1-\rho_2\rho_3)} \qquad (7)$$

and the apparent reflectance of the translucent ceiling, as seen from below, is

$$\rho_2' = \rho_2 + \frac{\rho_3\tau^2}{1-\rho_2\rho_3}. \qquad (8)$$

A comparison of equations (8) and (9) indicates that the apparent reflectance of the translucent ceiling is different when viewed from above and from below. The two expressions differ only in the substitution of ρ_3 instead of ρ_2. It is easy to show that

$$(1-\rho_2\rho_3)(1-\rho''\rho_3) = (1-\rho_2\rho_3)(1-\rho'\rho_3). \qquad (16)$$

Appendix B

Brightness (Helios) Uniformity for Infinite Room

The pharosage from a single infinite row of uniform fluorescent lamps is

$$D = \frac{F_L s}{2\pi S l}\cos^2\theta$$

where the quantities are indicated in Fig. 2. But

$$\cos^2\theta = \frac{1}{1+(x/l)^2}.$$

Thus for $\theta = 0$, the incident pharosage produced by an infinite number of lamps (no interflections), with uniform spacing s between rows, is

$$D_{max} = \frac{F_L(s/l)}{2\pi S}\left[1 + 2\sum_{n=1}^{\infty}\frac{1}{1+(ns/l)^2}\right]. \qquad (17)$$

Midway between rows of lamps,

$$D_{min} = \frac{F_L(s/l)}{2\pi S}\,2\sum_{1}^{\infty}\frac{1}{1+(n-\frac{1}{2})^2(s/l)^2}. \qquad (18)$$

Equations (17) and (18) give the illumination (pharosage) produced directly by the lamps. To these values must be added the illumination (pharosage) from the upper surface of the luminaire. This added illumination (pharosage) is equal to H_3 and is assumed to be uniform over the entire diaphosor. Then, from equations (13), (17), and (18),

$$c = \frac{1-2\sum_{1}^{\infty}\dfrac{(n-\frac{1}{2})(s/l)^2}{[1+(ns/l)^2][1+(n-\frac{1}{2})^2(s/l)^2]}}{1+2\sum_{1}^{\infty}\dfrac{1}{1+(ns/l)^2}+\dfrac{A}{(s/l)}} \qquad (19)$$

where

$$A = \pi\rho_3\left[1+\frac{\rho''(1+\rho_3)}{1-\rho''\rho_3}\right].$$

These equations were used in computing the curves of Fig. 8.

Appendix C

Brightness (Helios) Variation, Small Number of Rows

Consider now the incident illumination (pharosage) on the top of the translucent plates, produced directly by a small number of rows of lamps, neglecting interflections. The incident illumination (pharosage) produced by one row of lamps is

$$D = \frac{F_L(s/l)}{2\pi S}\cdot\frac{1}{1+(x/l)^2}.$$

Directly beneath the lamp, $x = 0$ and the pharosage is

$$D_1 = \frac{F_L(s/l)}{2\pi S}$$

At any other point,

$$D/D_1 = \frac{1}{1+(x/l)^2}. \qquad (20)$$

Equation (20) was used in plotting the curve for a single row of lamps. Superposition of these curves gave Figs. 9 and 10.

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Lighting a Sectional Exhibition Case

LIGHTING OBJECTIVE: To provide illumination in a museum display case free from glare, and of sufficient quantity to permit perception of detail.

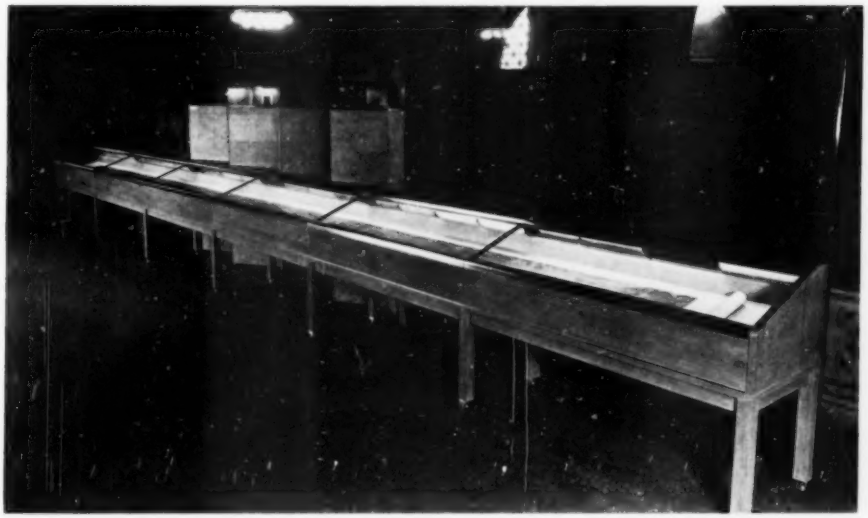

Figure 1.

Installation at the Metropolitan Museum of Art, New York City; designed by Laurence S. Harrison.

General Information: The case is composed of six six-foot units constructed of oak-veneer plywood, aluminum, and stainless steel framing, with a cover of clear, tempered plate glass. A plug-in coupling is provided between sections so they may be assembled singly or in multiples. For the 15th century Chinese scroll painting shown in the photographs a temporary display deck tilted 10° upward toward the back and covered with light ecru linen was added. The permanent decks are flat Upson board, 9 inches below the lamp housing.

Installation: A single, 72-inch, 4500K, T-8 slimline lamp is mounted with a rear mirror and a curved plastic louver in a stainless steel housing at the rear of the case as illustrated in Figure 3. The louver elements are 0.08 inch thick, spaced .04 inch apart, providing 45° shielding. They present greater surfaces to the light source as both the distance from the lamp to the deck and the angle of incidence decrease. The shadows behind the louvers, indicated by heavy diverging lines in the drawing, become narrower as both direct and reflected light is cast toward the front of the case. The maximum angle of incidence is 70°. However, for the tilted deck used to display

Figure 2.

(over)

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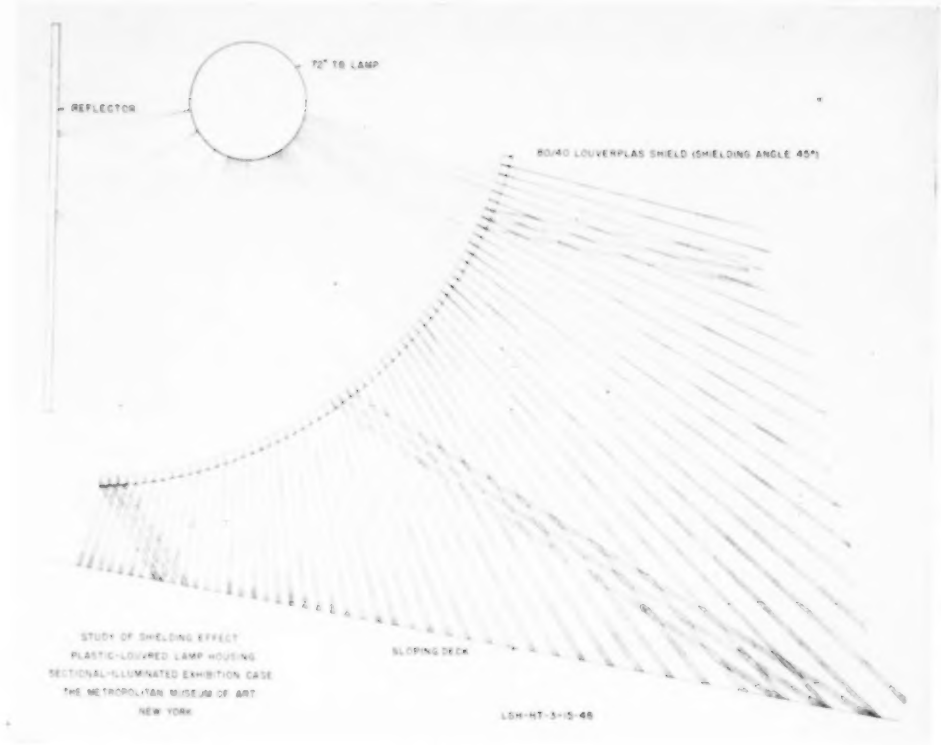

Figure 3.

the scroll a long, narrow mirror was mounted at the front of the frame, virtually concealed by the sash and so adjusted that the light is thrown back onto the display desk sufficiently to relieve most of the attenuation resulting from the 10° increase in the angle of incidence. With the lamps operated at 300 milliamperes and single lamp ballasts mounted underneath the cases the interior temperature does not rise more than 40° F. Lamps are replaceable by removing the stainless steel housing; the maintenance man has no access to the locked compartment housing the exhibit.

The flat deck showed a uniform brightness of 22 footlamberts measured through the clear glass lid, over the entire surface of the deck from front to back. The tilted deck measured 25 footlamberts at the rear and 20 at the front.

Lighting data submitted by Laurence S. Harrison, Metropolitan Museum of Art, New York, N. Y., as an illustration of good lighting practice and to aid in the design of similar installations.

Published by the Committee on Publications of the Illuminating Engineering Society, 51 Madison Avenue, New York 10, N. Y.

Photometry of Floodlights

By G. A. HORTON

The requirements to be fulfilled when testing floodlights are stated. Following this is a detailed description of an instrument which seems to fulfill the requirements in all respects. The complete floodlight testing range is described. The testing of floodlights utilizing electric discharge sources is discussed. Several methods for calibrating the test lamp and photometer are described. Comments are made with regard to the standard testing procedure.

FLOODLIGHTS should be tested in accordance with "Testing Procedure for Narrow Beam Enclosed Projectors," *Transactions, Illuminating Engineering Society*, Vol. XXXI, pages 508-519 (May, 1936), and supplement.[1] This "Testing Procedure" states — "As a general rule, a floodlight beam is inclined to be uneven in intensity. Traces of filament images are nearly always visible, and unless care is taken in the photometric exploration, will cause the results to be either too high or too low, depending upon the extent to which the images fall upon the photometric test plate. ... If the photometric observation is made to cover too small an area, these filament images may cause erratic results which are difficult to reconcile with the rest of the data. For this reason an integrating device should be used which will integrate the illumination over one square degree (20.94 inches x 20.94 inches for 100-foot testing range)."

The integrator now to be described consists of a 40-inch sheet metal hemisphere placed behind a sheet of flashed opal diffusing glass in the plane of the opening (Fig. 1). The interior of the hemisphere and the back of the cover placed in the opening are painted with white photometric sphere paint. The dimensions of the diffusing glass window are 20.94 inches x 20.94 inches. The integrating hemisphere has been fully dealt with by Benford.[2,3] Two methods of evaluating by means of photocells the light collected by the integrator are now described.

1. The photocell may be placed behind a small diffusing glass window which is shielded from the direct light from the large square window, as illustrated in Fig. 2. Since it is desirable to keep the size of the window in the rear of the hemisphere small,[4] this method allows of the use of only one or possibly two photocells with the result that the sensitivity of the device is somewhat low.

2. In order to increase the sensitivity, the photocells were placed inside the integrator with their light sensitive surfaces facing the rear of the hemisphere as shown in Fig. 3. In this way, as many cells as are required may be placed around the periphery of the instrument and connected in parallel. Cells used in parallel should, of course, have matched characteristics. Any of the commercially available barrier-layer type of photocells may be used. The photocell current may be measured by means of a microammeter, a deflection galvanometer, or if greater accuracy is desired, some type of zero-resistance circuit may be used.[5,6]

The type of integrator last mentioned is known to be in use in at least one other laboratory than that with which the author is associated. When used at a 100-foot test distance from the source, it seems to fulfill the requirement of integrating the illumination over an area of one square degree.

In addition to the integrator, another piece of equipment is required to complete the floodlight testing range. The floodlight being tested is mounted on a goniometer (Fig. 4). The platform upon which the floodlight is mounted is fastened to a steel bow which may be rotated vertically about a horizontal axis. This bow is swung in a cradle rotating horizontally about a vertical axis. By means of these two axes of rotation, the floodlight may be oriented to any desired combination of vertical and horizontal angles. An adjustment is also provided whereby the aperture of the floodlight is positioned on the intersection of the two axes of rotation. The goniometer is placed in such manner that the intersection of the two axes is 100 feet from the surface of the square diffusing glass in the integrator. A view of the floodlight testing range is shown in Fig. 5.

One disadvantage of this type of range is that the floodlight cannot be tested in its normal burning position for all measurements. This makes little difference when the light source is an electric filament lamp which is designed to operate in any position. However, the situation is different for

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floodlights utilizing the glass mercury lamps of the A-H1 type which are designed to burn in the vertical or near vertical position.[7] It has been the experience of the author that these lamps are not stable and light output is different in positions other than that for which they were designed and that there is always danger of burning through of the glass arc tubes. In the case of the E-H1 quartz mercury lamps there is no danger of burning through of the arc tube, but light output is somewhat different for different burning positions. It is understood that the manufacturer's lumen rating for mercury vapor lamps was assigned on the basis of vertical burning position.

A method has been described in the literature[8] wherein an incandescent source is substituted for the mercury lamp. A vacuum lamp of low efficiency in a tubular bulb lightly inside frosted simulates the candlepower distribution from the mercury lamp source. This, of course, presents calibration difficulties. Another alternative would be to use a mirror type distribution photometer[9] and mount the floodlight with the lamp axis vertical, the mirror being set for 100 feet test distance.

Calibration of Standard Lamp and Photometer

The "Testing Procedure" states — "An acceptable lamp of the desired size and service should be aged[9] and calibrated for current at rated lumen output, and also calibrated for intensity in a horizontal direction, as indicated by permanent markings (fiducial lines) placed on the bulb."

The calibration of the lamp for current at rated lumens may be done in the integrating photometric sphere against photometric standards of luminous flux which have been calibrated by a recognized standardizing laboratory.

The calibration of the lamp for candlepower in a horizontal direction may be conveniently done on a bar photometer against standards of luminous intensity which have been calibrated by a recognized standardizing laboratory. The lamp should be held at the same current as found in the method of the preceding paragraph.

White glass marking ink may be used for putting the fiducial marks on the lamp.

It is also pointed out that the Direct Method of photometry might also be used in which the square degree integrator may be calibrated for candlepower by means of a photometric standard lamp of luminous intensity and the floodlight test lamp calibrated for luminous flux in a photometric spherical integrator against photometric standard lamps of luminous flux. Because of the large number of various calibration readings involved, it is felt that this method permits of an accumulation of errors which may either cancel out or on the other hand combine to produce relatively large errors.

When calibrating the lamp for luminous intensity, it is desirable to select a point at which the candlepower does not change for small changes in the positioning of the lamp. Slight misalignment of the lamp when calibrating the photometer will then be of little consequence.

The test lamp may also be calibrated by rotating it at proper speed[10, 11] on a distribution photometer, and taking photometric readings at 10° vertical intervals (5, 15, 25, 35 degrees, etc.) about the lamp. Readings should also be taken at 0, 90 and 180 degrees vertical. After these "relative candlepower" measurements are made on the bare test lamp, the "relative lamp lumens" may be calculated by applying the proper annular lumen constants and the usual summation process. The final candlepower factor is then obtained by prorating the relative values to the manufacturer's rated lumen output for the lamp being used. The average 90° candlepower of the lamp may now be evaluated. The rotation of the lamp is then stopped at such place that the stationary 90° candlepower of the lamp is equal to the average rotating 90° candlepower and the fiducial marks applied. During this

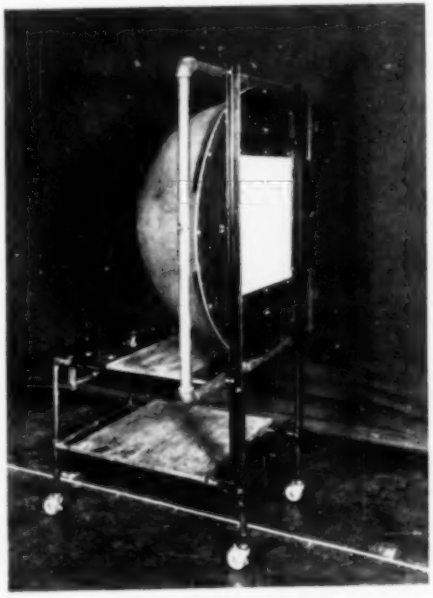


Figure 1. Hemispherical integrator.

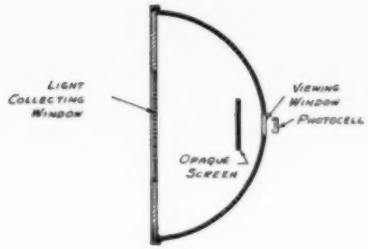
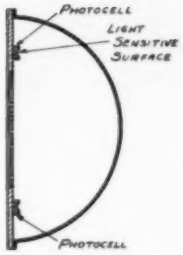


Figure 2. (Left) Preliminary photocell arrangement.

Figure 3. (Right) Final photocell arrangement.



test, it is convenient to hold the lamp current to a value equivalent to approximately 75 per cent of the rated lumen output of the lamp in order to insure stable lamp operation.

It has been the experience of the author and his colleagues that the light output of gas-filled electric filament lamps is the same whether rotating or stationary, providing the lamp current is held constant rather than the voltage. The light output will be very slightly different for different burning positions, however.

Instead of rotating the lamp as described above, it is of course permissible to take stationary readings about the lamp, providing enough vertical planes are taken to arrive at the proper average candlepower values.

The "Testing Procedure" states — "The standard lamp (which is obtained by the methods just described) is placed at a measured distance D (in feet) from the photometer head, so that the illumination received by the photometer plate is that established by the fiducial lines on the bulb. The assumed illumination is then

$$E = \frac{I}{D^2} \text{ Footcandles}$$

where I is the standardized fiducial intensity in candles. This value of E is used to find the scale constant of the photometer. When the scale reading is S, then

$$\text{Constant } C \times S = E \text{ footcandles."}$$

It is the opinion of the author that the calibration should be made at the same distance as that at which the flood light is tested, and the photometer may then be calibrated directly in candlepower per scale division.

The methods by which electric discharge lamps have been compared with electric filament photometric standard lamps have been described in the literature[12] and will not be taken up in this paper.

It has been stated that relative to the effect on the distribution of light caused by rotating electric discharge lamps, there has been found no effect large enough to be detected on either the 400-watt or 250-watt type H mercury lamps when rotated at 120 rpm.[12]

Figure 4. Goniometer.

Adjustment of Lamp in Floodlight and Method of Testing

The standardized test lamp is adjusted in the floodlight, the same electrical conditions maintained as in the calibration procedure and the distribution data taken.

The "Testing Procedure" states — "In general, the focusing of the lamp in the projector is to be done at a distance of 100 feet or more from the observing screen, and should be done at the same distance at which the photometric readings are made. In order to have a definite location of the

light source, (filament) lamps for base-up or base-down burning should be set in the floodlight with the lead wires away from the principal optical element. For lamps which burn in the horizontal position, the lead wires should be placed uppermost.

"The lamps should be adjusted in the floodlight to give the narrowest uniform and symmetrical beam."

No directions are given for positioning electric discharge lamps in floodlights, but this should make little difference as their distributions are nearly always symmetrical about the lamp axis and the dimensions of the light source are as a rule much larger than for electric filament lamps. The best practice might be to locate the lamp light center on the floodlight design light center position.

The author has found that in the case of floodlights utilizing narrow beam (specular) reflectors and electric filament lamps with the C-7A type of filament, it is often possible to pick up more flux in the beam if the floodlight is focused for a twin peaked beam. This consequently increases the beam efficiency.

The "Testing Procedure" states — "The method of taking observations is to traverse the beam with such spacings as to give approximately 100 reading stations uniformly spaced throughout the beam. . . . The test, therefore, involves a series of stations spaced in a rectangular manner over the area inside . . . the beam. . . .

"Approximate degree limits for the beam should be determined. This can usually be done by visual inspection. The spacing for the stations is taken so that approximately 100 readings can be made throughout the beam. To simplify the calculation, spherical constants are given for equal spacing, vertical and horizontal, by spaces of 1, $1\frac{1}{2}$, 2, 3, 4, 5 and 10 degrees. By a proper selection of these steps any size of beam can be explored by about 100 equally spaced steps.

"The method of computing the results involves, first plotting the change of candlepower across each of the horizontal traverses in the beam and working out from these data the isocandle and beam limit curves of the beam. The limits of the beam are to be taken as 10 per cent of the average of the ten highest candlepower values recorded in the prescribed exploration of the beam.

"The computation of the lumens in the beam . . . is made by summing the lumens of each individual test area, making suitable allowances in area and candlepower value when a test area lies partially within the beam and partially within the stray light area.

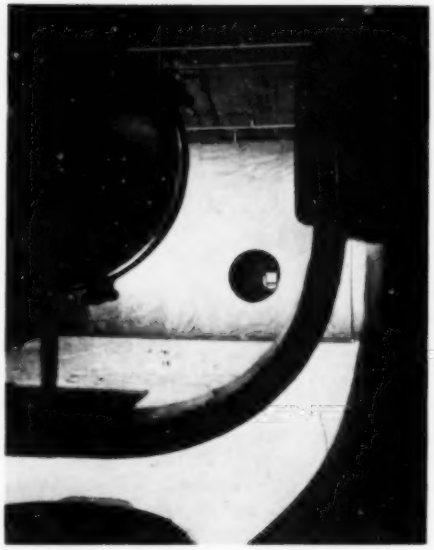


Figure 5. Floodlight testing range.

"The beam efficiency of the floodlight is computed using the ratio of beam lumens to the lumen output of the lamp. . . ."

Note that candlepower readings are taken in the centers of the rectangular areas or beam spacings.

In his visits to the various photometric laboratories, the author has found several different interpretations of the method of selecting the 10 highest candlepower readings for determining the beam limits. One laboratory was found to use the five highest values of averages of corresponding right and left candlepower values. In another laboratory candlepower values taken on the 0 degrees horizontal and vertical axes of the beam were included, if they were among the ten highest. In still another laboratory the ten highest readings were selected from the centers of the rectangles. It is the opinion of the writer that this last method is the correct one.

When plotting the change of candlepower across the horizontal traverses in the beam, the average of corresponding right and left values should be used. A typical test report for a floodlight is shown in Fig. 6.

In addition to nominal light source dimensions, it is felt that the actual dimensions of the light source of the test lamp used should be reported since the beam spread and maximum candlepower developed by the floodlight are somewhat dependent on this.

The accuracy of reproducibility of floodlight tests by the method described above is said to be of the order of 5 per cent.

It is convenient to use a hemispherical integrator of the type described by Benford[2,3] to check the calculated beam efficiency of floodlights, providing the beam is circular in cross section.

An electronically voltage stabilized alternating current power supply suitable for testing luminaires utilizing both electric filament and electric discharge lamps has been described in the literature.[9]

While a "Photometric Test Report" of the type of Fig. 6 does not give a true indication of the usefulness of floodlights, there does not seem to be any other convenient basis of assessment.

Floodlights are used to illuminate something and the problem might be simplified if measurements were made directly of the illumination they furnish under the conditions of use.

A convenient method for computing the lumen distribution and isolux diagram on a horizontal plane from the "Photometric Test Report" of Fig. 6, is described in "Approved Standards FL6-55 and FL6-60," National Electrical Manufacturer's Association, 155 East 44th Street, New York 17, N. Y. The resulting test report is illustrated by Fig. 7. It should be noted, however, that the lamp

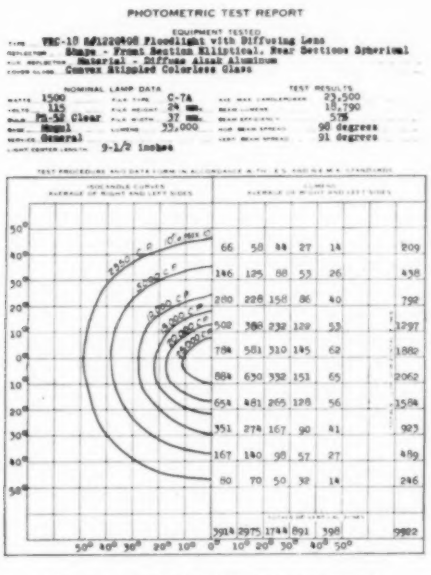


Figure 6. Typical photometric test report.

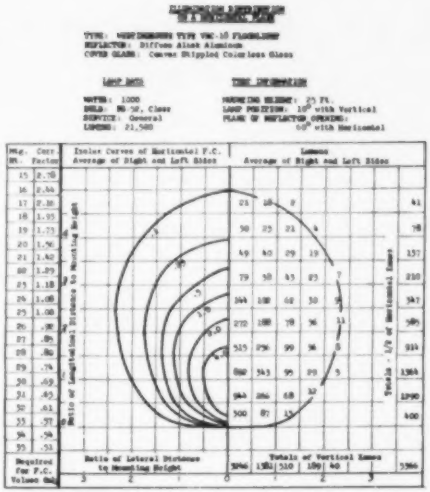

Isolux Curves of Horizontal F.C.
Average of Right and Left Sides
Lumens
Average of Right and Left Sides
Ratio of Lengthwise Distance to Mounting Height
Totals of Horizontal Lumens
Ratio of Lateral Distance to Mounting Height
Totals of Vertical Lumens

Figure 7. Illumination distribution on a horizontal plane.

lumen rating was changed from 33,000 to 21,500 for the particular application of Fig. 7.

A method which greatly improves the accuracy of floodlighting footcandle calculations will be described in the literature[13] in the near future.

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A Discussion of Fluorescent Lighting

By CONRAD BERENS, M.D.

Is fluorescent lighting harmful to the eyes? A recognized member of the medical profession gives an answer.

WHEN asked to discuss the suitability of fluorescent lighting, I immediately tried to obtain data concerning installations of fluorescent lighting of which I had some knowledge. No matter how much scientific data are available, experience concerning various installations affecting thousands of individuals gained over a sufficient number of years is desirable. This is true of all practices involving the health and welfare of human beings.

I have long been convinced that the most important single factor for eye comfort and health is to have light properly controlled and distributed so as to have no preventable glare. The amount of light is certainly important but it depends upon the visual task, the distribution of brightness, the visual efficiency of the worker and many other factors. Here, we are concerned with the inherent harmlessness or harmfulness of fluorescent light.

The majority of my patients, seen in every day practice, select from 18 to 20 footcandles of incandescent illumination using the Ferree-Rand lamp for reading a newspaper when sitting in a room in which there are only three ft-c of general illumination, partly daylight and partly artificial. Naturally, if general illumination is higher, they will select a higher level of illumination for reading. Of course, this depends upon the distribution of brightness in the visual field including the character of the fixtures. In speaking of the level of illumination, one informant stated that "When installing fluorescent lighting we found it was necessary to allow for extra watts per fixture on installation. We found that there was a decrease of approximately 30 per cent in lumens at desk level over a period of four to six weeks." This depends considerably upon the type of fixture and how often it is cleaned as well as upon actual decrease in output of the lamps.

Mr. Clarke of Seaman's Bank of Savings, New York City, claims two important advantages for fluorescent lighting over incandescent lighting: (1) "Fluorescent tubes create much less heat and therefore are much cooler during hot weather." (2) "Fluorescent tubes have much longer life, thereby saving a great amount of time used in replacing them." It was found that "employees working in our vaults asked for white fluorescent light, since a combination of daylight fluorescent, and the gray painted interior made it very depressing. Therefore color combinations are very important." The observations covering fluorescent lighting in use for seven years seem to indicate that when properly installed fluorescent lighting causes little if any eye defect.

I was deeply interested in examining the installation of fluorescent lighting in the Sperry Gyroscope Company through the courtesy of Richard Feinberg, the supervisor of the eye service section, medical department. Mr. James Kimball, the building electrician, reports that in maintenance, an area is serviced (washing reflectors, replacing them, installing new lamps) periodically at 4000 hours of lamp operation. These fluorescent lamps provide an initial level of illumination of 52 ft-c which decreases to approximately 30 ft-c in 4000 hours.

In the Sperry plant, in addition to the 30 ft-c available at the end of 4000 hours, using 3500°K fluorescent tubes, 150 ft-c are often supplied by auxiliary filament lamps such as the reflector lamps. In the plant that I inspected a considerable amount of natural light enters through wall windows and ceiling monitors, in addition. Because of this there are some seasonal complaints regarding glare, especially in the winter months when the sun is low in relation to the horizon and light enters directly in line of vision. This difficulty is somewhat overcome by waffle-type glass blocks, which direct light toward ceiling and seem to provide comfortable lighting. When fluted glass blocks were used the ocular complaints persisted until the blocks were coated.

From three years of experience, Dr. Feinberg has not found that fluorescent light affects vision adversely. Many who complained of their eyes and attributed the complaints to the illumination, were relieved by proper correction of refractive errors. Doctor Feinberg states, "We are definitely opposed to provision of tinted glasses as a panacea for

DR. BERENS is Managing Director of the Ophthalmological Foundation, Inc., New York, N. Y. Dr. Berens was asked through I.E.S. committee channels to prepare a discussion of some of the controversial questions raised in the paper "There Is Something Wrong with Our Fluorescent Lighting Applications" by L. D. Morgan, published on pages 275-285 of the June, 1945, issue of ILLUMINATING ENGINEERING.

lighting complaints, *i.e.*, wearing colored lenses." I believe that 100 per cent cure attributed to any one remedy for a large group of patients should be looked upon with suspicion.

Many of the complaints in the Sperry plant have been solved by their Committee on Illumination by such simple expedients as turning equipment to an angle where comfortable seeing could be obtained, providing baffles and shields, or providing additional auxiliary light.

Most ocular complaints involve the question of ocular fatigue. When we speak of eye fatigue we are approaching one of the most complicated problems in the field of medicine. Dr. Walter Miles summed up the work of the National Research Council's Committee on Visual Fatigue by saying, "When we speak of ocular fatigue socially we seem to be on fairly firm ground but when we consider the problem scientifically we seem to be lost in the woods." Unfortunately, there are few criteria we can use to determine the effects of insufficient or poorly distributed light upon the eye.

There are many factors which cause ocular discomfort and when illumination is being considered, the most important single factor, other than direct and indirect glare, is brightness difference. This has been proved by extensive research and was also the conclusion of the plant's Committee on Illumination.

No one could disagree with Mr. Morgan[1] when he says that lighting specialists should not install fluorescent lighting with bare lamps where critical seeing is performed for long periods, and that greater shielding angles should be provided for many industrial lighting units now in use. Certainly his recommendation in regard to the careful consideration of brightness is important and is important even in indirect or semi-indirect lighting.

As to injury to the eye by the small amount of ultraviolet light emitted by fluorescent lamps, there are bound to be individual differences in susceptibility, but I agree with Matthew Luckiesh and A. H. Taylor that the ultraviolet energy encountered outdoors and not in direct sunlight, would be more irritating to the eyes than that encountered in fluorescent lighting indoors. This is entirely a matter of quantity or degree.

In regard to Doctor LeGrand Hardy's personal feeling that fluorescent white light (around 3500°K) is less disturbing than fluorescent daylight, we have the report of the Seamen's Bank for Savings where fluorescent lighting has been used and the Sperry Company, where fluorescent white light has been in use for some time. In neither place have they found after long practical experience that they have any serious trouble from either type of lighting, provided direct and indirect glare is avoided and the intensity is not too great for the individual susceptibility.

When I was asked by Major F. K. Reid to recommend illumination for the rooms and study hall at West Point Dr. Luckiesh made various recommendations which were carried out. This installation has been in effect for some time and I have the following report which seems to indicate that fluorescent lighting, if properly installed, has little if any harmful effect on eyes of young healthy subjects.

(1) The system is designed to give a minimum of 35 ft-c over the entire study area, *i.e.*, taking into consideration among other things the fact that boys of cadet age often study in a tilted position with their feet on the desk. In actual practice our readings have averaged nearer 40 ft-c.

(2) Fluorescent tubes, 40 watt are used entirely.

(3) There has been no complain whatsoever about the stroboscopic effect.

(4) Similarly, there has been no organized complaint about glare. An attempt was made to keep brightness both as regard to fixtures and background as near the order of 200 ft-c as possible, and contrasts were kept low. Tests indicate that the specifications were met.

(5) There are no bare tubes. The fixtures provide 20 per cent direct lighting (through a diffusing plastic) and 80 per cent indirect lighting. This may well be one of the main reasons why we have experienced no series of cases of conjunctivitis or other irritations traceable to the lighting. There has been no increase noted in these cases since the installation of fluorescent lighting.

(6) The ft-c delivered by the installation have lessened over the period of observation. No definite figures can be given as yet but tests are in progress and statistics should be available soon.

(7) The general lighting in the rooms is never supplemented by local means; there are none of the latter. It was designed to deliver 100 per cent of the light from the overhead general lighting system mainly because of the aforementioned point that it is impossible to tie these boys down to one spot when they study. They are definitely perambulators. All previously existing desk lamps have been removed and are not permitted to be used.

(8) The lack of complaints concerning glare, fatigue, etc., has been noticed and the system is apparently working out satisfactorily.

We will be unable to answer in the last detail all of the questions which can be posed until a carefully controlled study is made of fluorescent lighting installations in many plants, offices and homes under varying conditions. All variable factors will have to be considered and especially the different human eyes being studied and their reactions to the quantity and direction of fluorescent lighting.

[1]Morgan, Lyman Day, "There Is Something Wrong with Fluorescent Lighting Application," ILLUMINATING ENGINEERING, Vol. LV, p. 275 (June, 1945).

Lighting Equipment Engineering Data Sheet

THE I.E.S. Committees on Testing Procedures for Illumination Characteristics and on Illumination Performance Recommendations have worked out a suggested form for presentation of minimum data on lighting equipment. It is intended that this Sheet be used as a guide by equipment manufacturers and testing agencies in preparing forms for presentation of photometric and other pertinent data on lighting equipment. There is no intention to restrict the data presented to that outlined on the Sheet, but it is suggested that all of the data called for be presented as a minimum. Some of the information listed may come from testing agencies and some from other sources.

The zones, angles and other information have been filled in on the sample form as if for a luminaire using fluorescent lamps. The boxes or sections, however, have been designed so that if the arrangement of lines and columns is printed alone, data on filament lamp luminaires, such as the RLM, will fit in. There are well-established test methods for these latter luminaires; all the results ordinarily given are not reviewed here.

The testing and presentation of data on fluorescent lamp luminaires are not so well established and the I.E.S. hopes, through its Testing Guides and this suggested Data Sheet, to bring about a highly desired uniformity.

General Information

The sample Sheet is designed to fold a little off center, so that when placed in a binder the holes will not interfere with opening the Data Sheet. The left hand side has space at the top just below the legend for letterhead, file references, etc., which will naturally vary with the customary practice of various laboratories and companies.

Below this are spaces for descriptive items pertaining to the luminaire. The one "General Description" should carry information as to lamps, total watts, etc., as well as to reflectances, transmittances, enclosing media, louvers, etc. (*i.e.*, details which influence or control the performance of the luminaire and hence the results of photometric tests). Auxiliary equipment should be described in detail, for example, "Ballast, two-lamp, small cross section, high power factor, 118 volts, 60 cycle."

The ICI classifications are already well known and need no further explanation. The I.E.S. classifications are being developed by the Committee on Illumination Performance Recommendations and will be presented to the Society in the near future. Space for this classification is provided on the proposed Data Sheet.

Distribution Curve

The customary distribution curve occupies most of the remaining space on the left hand page. Many users will already possess engraving plates for the polar graph and will naturally use these in printing Data Sheets. For any users contemplating printing Sheets for the first time, the square arrangement shown may have an appeal. This square plate may be oriented to have the center of the graph above, below, or to either side of the center of the square for direct, indirect and asymmetric fixtures respectively.

The name of the testing laboratory, the report number and date are of the utmost importance and any adequate Data Sheet includes them. Spaces for this information are given just below the distribution curve. Although it is not recommended, the actual curve and the rest of the distribution data might be obtained by a maker from a testing laboratory and coefficients of utilization calculated therefrom. When this is the case the testing agency's name and report number and date quite properly belong with the distribution curve. The fact that the other data are calculated from this curve should be stated on the right-hand page where such derived information appears.

Distribution Data

The right hand page provides a box for Distribution Data. This is customarily given by the testing agency. It should be noted that the mean zonal candlepower called for may not always occur at the corresponding mid-zone angle, and therefore may not be represented by any of the distribution curves given on the polar graph.

Light Flux

The Light Flux box provides spaces for the lumen sums as these values are used for calculation of coefficients of utilization as outlined on pages 8-14 and 8-15 of the *IES Lighting Handbook*.

LIGHTING EQUIPMENT ENGINEERING DATA SHEET

Manufacturer's Company Name _____

Designation of Luminaire _____

General Description _____

Reflectances, Transmittances _____

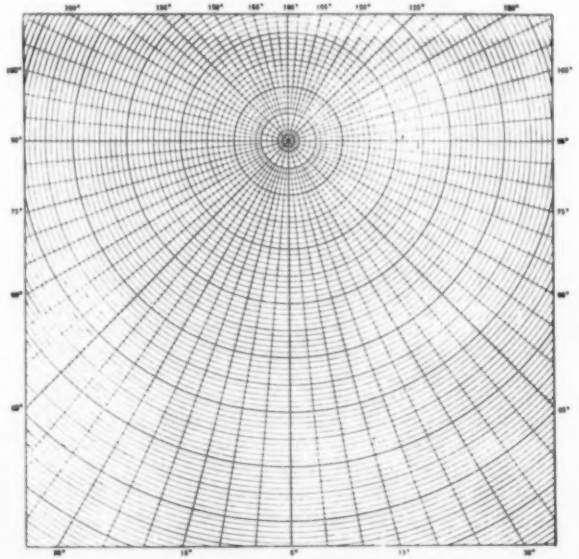
Lamps _____ (Number, type and watts each) Rated Lumens Each _____ Total Watts _____ (Including auxiliary equipment)

Auxiliary Equipment _____

Classification ICI 185

PHOTOMETRIC TEST DATA

Candlepower Measured at ____ Feet



(Name of Laboratory) _____ (Report No.) _____ (Date) _____

DISTRIBUTION DATA

Mid-Zn Angle	Mean CP	Mid-Zn Angle	Mean CP
180		85	
175		75	
165		65	
155		55	
145		45	
135		35	
125		25	
115		15	
105		5	
95		0	
90			

LIGHT FLUX

Zone	Lumen Sums	% Bare Lamp	(Unassigned)
0-180			
0-90			
0-60			
0-40			
0-30			

Efficiency of Luminaire

(Space for Sketches of Luminaire)

MAXIMUM BRIGHTNESSES

Zone	CROSSWISE B	CROSSWISE Angle	CROSSWISE Aper.*	ENDWISE B	ENDWISE Angle	ENDWISE Aper.*
0-45						
45-60						
60-75						
75-90						

Shielded Zones below horizontal
Crosswise ____ Endwise ____

CHARACTERISTICS OF LUMINAIRE

DISTRIBUTION	SPACING and MAINTENANCE FACTOR	Ceiling	75%			50%			30%	
		Walls	50%	30%	10%	50%	30%	10%	30%	10%
		Room Index	COEFFICIENTS of UTILIZATION							
	Spacing not to exceed	J								
		I								
		H								
	MF†	G								
		F								
		E								
	G	D								
	M	C								
	P	B								
		A								

* Test instrument aperture dimensions in inches.
† Maintenance factor for Good, Medium and Poor conditions.

Again, if the box alone is printed, there is an unassigned space which may be used for the lumen sums called for in RLM and filament lamp high-bay luminaire testing.

Maximum Brightness

The Maximum Brightness box indicates certain specific zones in which values should be given. The Committee on Illumination Performance Recommendations is developing a system of classifying luminaires by maximum brightness in the zones shown on the sample Sheet. This work is progressing and its ultimate aim is to enable the specification in terms of brightness distribution of luminaires for specific uses. It is hoped that tests by agencies and manufacturers will be of sufficient scope to permit presentation of specific maximum brightness data as outlined, as these are essential to the luminaire classification procedure.

Following the "Guide for Testing Fluorescent Luminaires, 1948," the Maximum Brightness called for is the average brightness of a one-inch square, or of one square inch rectangular area with the major dimension selected to suit the particular area being measured but not exceeding four inches. A column is provided for the dimensions of the instrument aperture. If the luminaire is asymmetric the maximum brightness (taken as above) should be measured both perpendicular and parallel to the longitudinal axis in the indicated zones. Additional measurements (both maximum and minimum) may also be necessary to adequately describe the performance of the luminaire. If maximum brightness occurs on the simulated ceiling (where used), it should be measured as above. Sufficient space is provided in the box for any additional brightness data which may seem desirable. Brightnesses may be expressed in footlamberts or in candles per square inch. In either case the unit used should be in the heading of the column.

Sketch of Luminaire

To the right of these three boxes, space is provided for a sketch of the luminaire. It is recommended that the angles at which the maximum brightnesses were found be shown by arrows with the tip indicating the actual point on the luminaire. It is suggested that the sketches be as realistic as feasible with dimensions (overall, louvers, panels, husk and spill shield clearances, etc.) shown. Directly below this space is a block for recording the extent of the shielded zone for crosswise and lengthwise viewing. This is the zone or zones over which the light source is shielded from direct view. This angle is usually stated in degrees below horizontal. In some cases where the light source is intermittently visible in the lower hemisphere greater detail in describing the shielded zones may be required.

Characteristics of Luminaire

This block follows the form employed in the *IES Lighting Handbook* (page 8-14).

The "I.E.S. Guide for the Photometric Testing of Fluorescent Luminaires, 1948," should be consulted for testing details for this class of equipment. Appendix B of this guide gives an earlier version of the Lighting Equipment Engineering Data Sheet. The present suggested Sheet has been amplified and the boxes designed to have sufficient space for presentation of minimum data on filament lamp luminaires.

Respectfully submitted,

COMMITTEE ON ILLUMINATION PERFORMANCE RECOMMENDATIONS

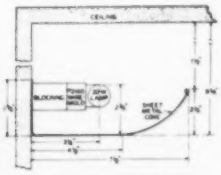
J. F. Parsons, Chairman	W. F. Little
G. R. Baumgartner	R. S. Rogge
B. S. Benson, Jr.	R. P. Teele
W. H. Kahler	G. P. Wakefield

This simple umbrella light installation consists of a swivel socket on a bracket, a weatherproof gasket, and a 150-watt PAR-38 projector lamp, providing lighting for a cool drink on the terrace after dark. Photo courtesy of Westinghouse Electric Corp., Bloomfield, N. J.

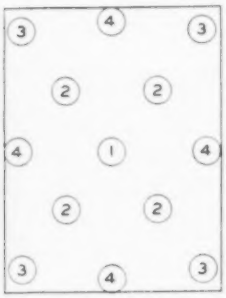
Lighting a Dining Room

LIGHTING OBJECTIVE: To provide flexible illumination of varying levels in a formal dining room, (1) to highlight the table, and (2) also to create pleasant general room lighting.

General View of Dining Room



Section Through Cove



Position for Footcandle Readings

Installation at Hartford, Connecticut

General Information: The room is 12′ x 13′3″, with an 8′ ceiling. The woodwork, ceiling and window-end of the room are painted white, while the interior walls are treated with paper of delicate Chinese Modern design. The wallpaper motif—a green vine pattern with light accents of gold, black, and Chinese red on a white background—is reproduced identically in the drapery fabric. Wall-to-wall carpeting is two-tone green. Furniture is mahogany of traditional design.

Installation: A single recessed "Annulite" luminaire 13⅞" in diameter is provided to highlight the dining room table. This unit employs one 150-watt, silvered-bowl, inside frosted lamp, burning base up, and concealed in the center island. Above and outside the island is a composite gold-plated reflector. The visible vertical surfaces of the island and outer ring are finished in a dull red, and horizontal surfaces are white.

Fluorescent lamps concealed in sheet metal coves on opposite walls the length of the room provide soft even illumination throughout the dining room. Each cove is painted white inside and outside, and is equipped with four, 30-watt, 4500° white fluorescent tubes spaced in a single row. Soft white and white (3500°) tubes were tried in this installation, but failed to bring out the whiteness of the walls and the colorings of the room as successfully as did the 4500° white tubes. Wiremold wiring channel #2100 is used in each cove and is installed on blocks several inches from the wall to avoid a shadow effect on wall or ceiling at the "between tube" spacings. Ballasts for all fluorescent tubes are installed in the basement. Either the cove lighting or the center incandescent unit may be used independently

(over)

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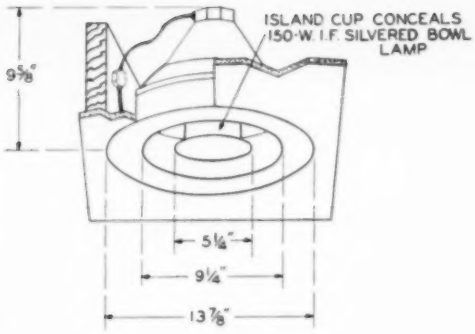

At left, Close up of Dining Room Table. Details of Ceiling Fixture Used are Shown Above.

of the other with satisfaction, but the most pleasing effect is gained by the combination of both arrangements.

Initial footcandle readings (after 100 hours) were taken on the dining room table with cove lighting only, and with center ceiling unit only, as indicated below:

Position (See Sketch)	*Cove Lighting Only*	*Ceiling Fixture Only*
(1)	16.0 ft c	43.0 ft c
(2) (average)	15.9 "	33.4 "
(3) (average)	15.7 "	12.0 "
(4) (average)	15.9 "	25.6 "
Total Average	15.8 "	25.2 "

The brightness reading taken on the wall immediately above the cove was 225 footlamberts. Ceiling brightness above the cove near to the wall was 275 footlamberts.

Equipment: The ceiling luminaire, "Annulite" No. AL-49, is manufactured by Rambusch Decorating Company, New York, N. Y.: Wiring channel #2100 (installed in custom-built sheet metal cove), by Wiremold Company, Hartford, Conn.

Architect: Royal Barry Wills, Boston, Mass.
Decorator: G. Fox Company, Hartford, Conn.

Lighting data submitted by Miss Myrtle Fahsbender, Director of Residential Lighting, Lamp Division, Westinghouse Electric Corporation, Bloomfield, New Jersey, as one solution of this home lighting problem and to suggest ideas which may be used in solving similar problems.

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Series XIV 8-49

The Characteristics of Cold Cathode Fluorescent Lamps

By EUGENE S. WEST

This paper describes in some detail the electrical, photometric and physical characteristics of cold cathode fluorescent lamps, discusses the extent of standardization of cold cathode fluorescent lamps and tells the steps that are being taken toward further standardization. The paper discusses "smashing point" in connection with cold cathode fluorescent lamps.

THE COLD cathode fluorescent lamp is being utilized in continually increasing quantities as an economical source of interior illumination. For this reason a discussion of the peculiarities of this mutation from the family of fluorescent gas discharge light sources may prove helpful. Detailed knowledge of all of the characteristics of a light source permits the lighting designer to apply it most effectively.

Electrical Characteristics

Understanding the electrical characteristics of cold cathode fluorescent lamps requires some knowledge of the phenomena associated with the conduction of electric current through gases.

If we place a cold cathode lamp in the circuit of Fig. 1 and gradually increase the direct voltage the current through the lamp will vary as shown in Fig. 2.[1]

The smallest voltage produces some current (*o-a*). This occurs because all gases have a few ions and free electrons which begin to migrate when a potential gradient is applied. As the voltage is increased the current levels off (saturation) (*a-b*) because electrons are being attracted to the anode as fast as they occur in the gas — but no electrons are accelarated enough to produce ionization by collision. This voltage is the ionization potential of the argon in the carrier gas and is about 15.7 volts. The current produced thus far is of the order of one microampere and of no significance for lighting purposes since no light is emitted.

From (*b*) on, increases in voltage again cause slight current increases, as some ionization due to electron collisions begins to occur. As voltage is increased further, the rate of the current increase rises more rapidly as the positive ions gain sufficient speed to cause the emission of more electrons from the cathode.

Up to the voltage at (*c*) no measurable light has been emitted. Some photons may be emitted due to recombination. At (*c*) breakdown occurs. The voltage across the lamp which is necessary to cause breakdown is a function of the carrier gas used and its pressure. It would seem logical that the commercially available inert gas having the lowest ionization potential at room temperature would be used as the carrier. Following are the ionization potentials of three of the rare gases.

Gas	Ionization Potential	Mass of Ion (Grams)	Atomic Weight
Neon	21.47 volts	3.3×10^{-23}	20.183
Argon	15.69 "	6.6×10^{-23}	39.944
Krypton	13.94 "	14×10^{-23}	83.7

It would appear that krypton is the best of the three. However, it is too expensive because of its relative rarity (0.0001% of air). Next best would be argon, and this is the gas used, (together with a very small percentage of nitrogen).

The initial discharge is through the carrier gas, and the mercury vapor that is present. The heat from that discharge very soon increases the mercury vapor pressure, and the current is then entirely carried by the mercury vapor. Lamps without carrier gas will not start in ordinary circuits.

Returning to Fig. 2, in the region between (*d*) and (*f*) we have a normal glow discharge which is characterized by a voltage drop across the lamp that is nearly independent of the discharge current. The current is limited by the impedance in the external circuit. The current density at the cathode is constant and independent of the discharge current. A greater or smaller area of the cathode is utilized as an emitter and conductor as the current varies.[7]

If we reduce the series resistance and permit the current to rise beyond that at (*f*) the discharge voltage increases with increasing current as shown by (*f-g*). This discharge is called an abnormal

MR. WEST is with the Catho-Lite Company, Inc., Baltimore, Md.

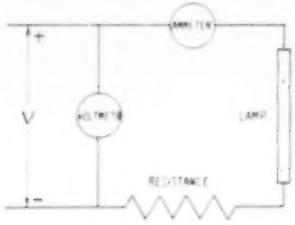

Figure 1. (Left) Circuit for obtaining static characteristics of electric discharge lamps.

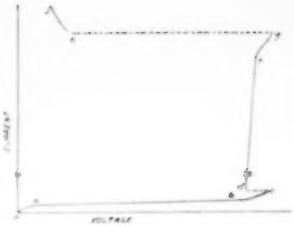

Figure 2. (Right) Static characteristics of cold cathode fluorescent lamp.*

glow. The entire cathode conducts and the current density and voltage drop at the cathode increase with increases in discharge current. Fig. 3 shows the characteristics of normal and abnormal glow discharges. A further increase in the current beyond (*g*) results in a sudden transition to a low voltage discharge called an arc. Fig. 2 (*h-j*) shows the negative resistance characteristic of an arc.

The normal cathode drop depends on the combination of gas and electrode material involved. For a pure iron electrode in argon the drop is 165 and in mercury vapor the drop is 298. When composite surfaces such as alkaline earth oxides are used, the drop is greatly lowered and becomes about 95 volts. The cathode drop of various materials increases nearly linearly with their work functions. This is reasonable, for the maintenance of the discharge depends on the emission of electrons from the cathode. Emission of electrons from the cathode is primarily by three means—thermionic emission, secondary emission and field emission. The thermionic emission results from the escape of some of the electrons which are moving rapidly at random within the metal because of its high temperature. Secondary emission, which accounts for the largest part of the current, is the emission of electrons primarily by the bombarding action of positive ions. Field emission of electrons occurs due to the potential gradient existing near the surface of the cathode.

The differences between glow and arc discharges in the space between electrodes are minor. There is one significant difference at the cathode, however. In an arc, current flows from a tiny area of the cathode. In that area temperature is very high. One of the physical effects of the striking of the arc on the electron emitting material at that point is to knock some of the emitting material off the cathode. In a glow discharge, electrons are emitted from a relatively large area of the cathode. The temperature of the emitting material is less and practically no emitting material is dislodged when the discharge starts.

The cathode of a glow discharge is subject to severe bombardment by positive ions. Gradually this causes a disintegration of the cathode surface which is called sputtering. The amount of material sputtered in a given period increases with reduced gas pressure. The particles lost from the cathode are deposited on nearby cooler surfaces. Such a deposit causes a progressive darkening of the glass wall of a discharge tube unless it can be accumulated some place where it will have no effect on lumen output.

It was formerly thought that the rare gas in an electric discharge is trapped by these disintegrated particles in the sputtered deposit. No doubt some of it is, but only a small amount. Actually, the positive ion bombardment is the primary cause of the rare gas absorption which eventually lowers the gas pressure to the point where the lamp will no longer strike.[2] The gas is "shot" into the cathode by bombardment. The gas penetrates into the interior of the metal and is there dispersed by diffusion. The absorption is proportional to the current and time, is independent of the form and length of the tube and the amount already absorbed by the cathode and is a function of gas pressure. The lower the gas pressure the faster the absorption. The rate of "clean up" also depends on the kind of gas and the electrode material, shape and temperature.

The actual useful radiation from a cold cathode

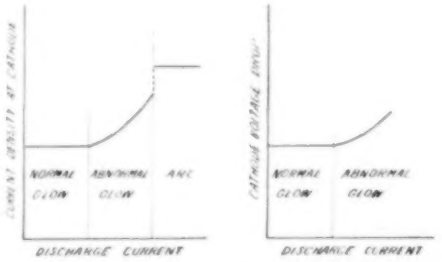

Figure 3. Characteristics of normal and abnormal glow discharges.**

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**By permission from *Gaseous Conductors*, by J. D. Cobine, copyrighted 1942, by McGraw Hill Book Co., Inc.

lamp is from the "positive column" of the discharge. The positive column extends nearly the full length of the space between the electrodes. Near and within the cathode some complicated phenomena occur which need not be considered here. The positive column of a discharge is not to be confused with the "luminous length" of a cold cathode lamp. The luminous portion of the lamp is the part from which light is emitted, which is the portion that is phosphor-coated.

If the lamp gas pressure is held constant, the voltage across it must be increased as tube radius is reduced in order to sustain the discharge. This is a result of the fact that in the tube of smaller radius there is greatly increased loss of ions by diffusion to the walls where recombination takes place.[1] The walls of a discharge tube can be considered an infinite "sink" for ions, and since these ions are usually assumed to follow the laws of gaseous diffusion, the smaller tube allows for greater amounts of deionization by diffusion to the walls.[10] The energy radiated from the column is only a fraction of the total energy consumed by the lamp. The rest of the energy is lost by diffusion and in raising the temperature of the gas.

There is also a voltage drop at the anode. It is of the order of the ionization potential of the gas—about 10.4 volts for mercury. The anode drop is relatively small with respect to that at the cathode. The anode drop increases at very low pressures because of the increased diffusion to the walls and the lowered ionization efficiency but is independent of pressure in the ordinary range of pressures encountered in cold cathode lamps.

The characteristics of cold cathode discharges discussed above are static characteristics obtained by slowly varying the current so that equilibrium conditions are obtained at each point. If the current of the discharge is caused to vary rapidly, a departure from the static characteristics occurs due to what might be called "ionization inertia." At every half cycle the electrode polarity is interchanged. Fig. 4 shows the current and voltage through a typical cold cathode lamp as a function of time at 60 cps.[7] Further study of the dynamic characteristics of cold cathode lamps should be made. Lamp improvements might result.

The pre-heated cathode (or hot cathode) fluorescent lamps used today are are discharge lamps.

Cold cathode lamps are operated on alternating current by means of a high-voltage low-power transformer. The starting voltage of a lamp is relatively high, whereas the operating voltage is relatively low, so that the transformer must have a high leakage reactance to limit the current.

The transformers are usually built with a magnetic shunt between the primary and secondary windings which greatly increases the leakage reactance. This results in a natural low power factor for the installation unless a correcting capacitance is provided.

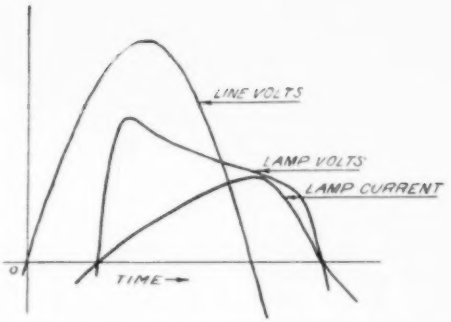

Figure 4. Current and voltage of cold cathode lamps as a function of time with 60 cps input voltage.

The radiation emitted by electrical discharges in gases is confined to the line spectra of the elements involved and to the band spectrum characteristic of the molecules present. The collisions in the positive column displace electrons of the normal atomic mercury orbit, and radiations of particular wavelengths result as the displaced electrons return to their normal lower energy positions in the atomic structure.[3]

A low pressure mercury discharge such as that in a cold cathode lamp radiates a considerable portion of its energy in single wavelength lines just as a radio station sends out its energy at just one wavelength to which your home receiver can be tuned. At the pressure used at present, the strongest mercury line is at 0.2537 microns.

Certain materials called phosphors have the property of absorbing energy at one wavelength and reradiating it at other wavelengths which are in the visible spectrum. Some phosphors require the presence of an activator in order to fluoresce.[4] The light emitted by phosphors is greatly reduced by small amounts of certain impurities.

A phosphorescent substance radiates only when subjected to excitation. A phosphorescent substance is fluorescent and also radiates after excitation is removed. For different substances the period of phosphorescing may vary from microseconds to hours.

By coating the inside of the tubing, then, with suitable phosphors the radiation from the positive column, most of which is not visible, can be utilized to produce visible light. By choosing particular phosphors and mixing them in various proportions,

light of various colors can be produced. The efficacy of transformation is also affected by the phosphors used.

Present phosphors are transforming energy at about 80-90 per cent efficiency within the quantum limit (a wavelength transformation of energy can occur only at a maximum limiting efficiency represented by the ratio of the wavelengths involved.)[5] Because the ratio of wavelengths of exciting ultraviolet to phosphor radiation is about 50 per cent, an energy loss of about 50 per cent is involved.

Photometric Characteristics

The greatest lumen output from a fluorescent lamp will occur when phosphors are irradiated with the largest amount of energy at 0.2537 microns. (Actually there are phosphors whose maximum sensitivity is at other wavelengths and electric discharge lamps have been made with mercury pressure held so that the largest radiation is at the optimum sensitivity wavelength of these other phosphors. Such lamps are not commercially important.) The largest 0.2537 micron radiation occurs when the mercury pressure is 6 to 10 microns. This occurs when the bulb temperature is about 40-45 degrees C. (100-105 degrees F.). In no-draft conditions, it has been found for most fluorescent lamps that the bulb wall temperature is optimum when the energy dissipated in the discharge is about 0.13 watts per square inch of phosphor area.[6]

Current density is defined as the current divided by the cross sectional area of the conductor. For a cold cathode lamp this becomes the operating discharge current divided by the cross sectional area inside the tube and is usually expressed as milliamperes per square millimeter.

The efficiency of conversion of the input power to the lamp into 0.2537 micron radiation increases somewhat as the current density is decreased. This explains why the larger diameter lamps are the most efficacious. Table I gives some typical initial lumen output values for some typical cold cathode fluorescent lamps.

Initial lumen output figures are those obtained after fluorescent lamps have been operated under specified normal conditions for 100 hours. It is not until electric discharge lamps have been operated 100 hours that their electrical and photometric characteristics become fairly constant. During the first 100 hours there is a decline in lumen output amounting to about 10 per cent of the initial value.

Lumen output figures for electric discharge lamps are practically meaningless unless the color, diameter, length and operating current are also given, because variation of any one of these factors changes lumen output. Other factors such as ambient temperature, waveform, thermal equilibrium of the lamp and instrumentation during testing also affect lumen output figures. However, the values and procedures covering these latter factors are fairly well standardized, and are assumed to be standard unless otherwise specified.[8]

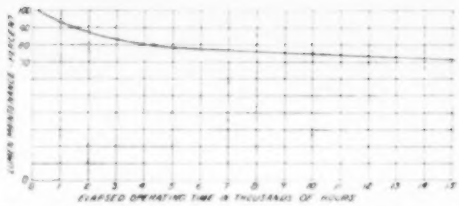

Figure 5. Composite lumen maintenance curve for 20 and 25 mm diameter lamps.

Cold cathode lamps used in fixtures (multiple operation) are usually operated at somewhat higher current than those operated in series on a series-circuit transformer operating at rated load. In some cases the current in the series circuit results in slightly higher efficiency (lumen output divided by lamp watts), a little less reduction in lumen output with time, but also gives less lumen output.

Initial lumen output figures are the ones commonly publicized by lamp manufacturers. This is done even though these figures make the lamps appear to be more efficacious than they actually are. All commonly used light sources diminish in lumen output with time. Therefore the initial figure is the highest the lamps will ever produce. But it is easier and cheaper to obtain initial lumen output figures for lamps than it is to obtain some of the less misleading figures.

The lumen output characteristics of cold cathode lamps are more clearly presented by a lumen maintenance curve such as Fig. 5. From the curve of Fig. 5, one can determine the total lumen hours to be expected from the lamp. The curve of Fig. 5 is called a "lumen maintenance" curve. The reduction in lumen output is sometimes called the "depreciation" of the lamp. Lumen maintenance depends on current density, the characteristics of the electrode, the characteristics of the phosphors, internal pressure, purity of gases used, extent of degassing accomplished in processing, and to a minor extent, to factors in operation beyond the control of the lamp manufacturer (voltage, ambient temperature, etc.).

As Fig. 5 shows, the average depreciation of a well made cold cathode lamp operated at 96 milliamperes is approximately 75 per cent of the initial value after 10,000 hours of operation.

In general, lumen maintenance is improved as current density is reduced. However, lumen output

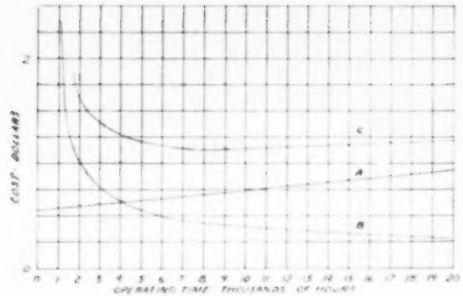

Figure 6. Light cost curves.

diminishes almost in proportion to current density reduction so optimum operating current must be chosen after evaluation of both of these factors.

Specific electrode design can reduce end blackening somewhat and increase in the surface area of an electrode will reduce general blackening due to sputtering of the electrode. Impurities present in the electrode metal increase its blackening effect.

Uniform blackening along the entire length of the lamp occurs because the mercury combines with the material of the phosphor. A thin mercury compound film gradually develops around the phosphor particles, which absorbs their radiation and the radiation from the mercury arc. Heating of the phosphor will drive off this film but reforming of the film occurs rather rapidly thereafter.

Photodecomposition of the materials of the phosphors also contributes to the gradual reduction in lumen output.[9] Impurities present inside the lamp also cause depreciation. Such impurities may be introduced by the carrier gas or the mercury or they may be occluded by the electrodes, tubing or phosphors and not completely driven off during processing. Poorly made lamps blacken rapidly. Lamps that "swirl" for any length of time (except just a few minutes at the very start) during the first 100 hours of life have been improperly processed and will give lumen output lower than normal. It is believed that the swirling may be caused by loose particles of emissive material moving in the arc stream, or by the presence of carbon dioxide inside the lamp.

Depreciation, as we have spoken of it, is entirely within the lamp and would occur even if the outside of it were kept spotless.

One other aspect of lumen maintenance should be mentioned here. It is "smashing point."

Throughout life, in a given installation, a cold cathode lamp will consume nearly constant power. A watt-hour costs so many cents, depending on the local power rate. For a new lamp, a watt-hour consumed will produce so many lumen-hours of light. We can compute then the cost per lumen hour. Later in life, a watt-hour consumed will produce fewer lumen-hours of light. At that time cost per lumen-hour will be higher. By successive similar computations Fig. 5 can be used to obtain curve *A* of Fig. 6 which is power cost per million lumen-hours as a function of hours of operation. The power rate is assumed to be 2¼¢ per kwh. The cost of a lamp plus relamping is assumed to be $5.00. An installation can be relamped after any specified number of hours of operation. A simple way of recording total hours of operation is to install a Time Totalizer—a device consisting of an electric clock driving a counter. Suppose we relamped after 4000 hours of operation. From Fig. 5 we can determine the average lumen output during this period. This figure times 4000 is the lumen-hours from the lamp. If we divide lamp cost plus relamping cost by lumen-hours we obtain lamp cost per lumen-hour for relamping at 4000 hours. Similar computations can be made for relamping at other periods and curve *B* of Fig. 6 can be plotted. It is lamp cost per lumen-hour as a function of hours of operation.

All other factors being equal, cost of light is the sum of lamp and relamping cost plus power cost. Adding curves *A* and *B* we get curve *C* which is total cost per lumen-hour.

For the particular case used as an example the minimum cost per lumen-hour occurs at some point after 15,000 hours. At this point the lamp should be replaced by a new one. This is the "smashing point." Beyond this point it is uneconomic to continue to operate the lamp even though its life may be indefinitely long.

Physical Characteristics

Most of the cold cathode fluorescent lamp manufacturers are making standard lamps at the present time. A few manufacturers are making non-stand-

Figure 7. Details of lamp end construction now widely used and lampholder widely accepted.

TABLE I

Some Characteristics of Standard Straight Cold Cathode Lamps

Lamp Designation	Nominal[1] Length	Nominal Diameter	Warm White Initial Lumen Output	Warm White Initial L/W	Lumen Readings at Following operating Currents
64T6	64"	20 mm	1525	37.2	.085 amps
76T6	76"	20 mm	1850	39.1	.085 amps
84T8	84"	25 mm	1800	41.0	.090 amps
93T8	93"	25 mm	2000	41.8	.090 amps

[1]Tolerances on over all length are ± ¼".
[2]This table shows approximate *overall* efficiencies including transformer loss.

ard lamps of unusual lengths and some with caps requiring unusual lampholders. The characteristics of the most widely used lamps made by most manufacturers are shown by Table I.

Further standardization of cold cathode lamps is now under consideration by the Committee on Electric Lamps C78, of the American Standards Association.

Fig. 7 shows details of lamp end construction as now widely used and of one type of lampholder which is widely accepted.

The author gratefully wishes to acknowledge the courtesy and assistance of Prof. P. H. Moon in reading this article in manuscript and making several suggestions for its improvement.

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Permission to publish Figs. 2 and 3 has been obtained from the McGraw-Hill Book Co., Inc.

Exterior illumination of a building of futuristic architectural design is demonstrated by the effective floodlighting of the Prudential Insurance Company, Los Angeles, California. Ralph Phillips, consultant, planned the lighting; the building design is by Wurdeman & Becket, architects. Photo, courtesy of the S & M Lamp Company, Los Angeles, California.

TELECAST

LIGHTING NEWS OF CURRENT INTEREST

Planned Lighting and Job Contests Feature Program of East Central Regional Conference

Bringing to a close the 1948-49 series of I.E.S. Regional Conferences, the East Central Region convened at the Penn-Harris Hotel in Harrisburg, Pa. June 6-7. The region embraces the Pittsburgh Section, the Capital Section in Washington, D. C., the Philadelphia Section, the Baltimore Chapter, and the Eastern Pennsylvania Chapter which served as host for the conference. Formal registration accounted for a total of 128 persons, 105 men and 23 women. Casual visitors brought the gross attendance up to about 146.

Central theme of the conference program was *Planned Lighting* to which two entire sessions were devoted, each featuring a different aspect. One of these was a review and discussion of programs of personnel organization and training methods, and of field promotional and educational methods that have proved effective and successful in different parts of the region. Parallel emphasis was placed on the practical aspects, with a session devoted to a "My Most Interesting Job" contest, a competitive presentation of an illustrated description of an effective planned lighting installation from the territory of each of the Sections and Chapters of the region. Other topics, of technical and general nature, reported later in this item, rounded out a well-balanced program.

Feature of the opening session was a welcoming address from Franklin Moore, Managing Director of the Penn-Harris Hotel. Mr. Moore reviewed significant highlights of the history of the industrial and economic growth of the United States, and indicated that a challenging opportunity for effective and useful public service confronts the people and the organization which comprise the lighting industry.

President Lee Tayler emphasized the practical down-to-earth value of the I.E.S. Regional Conference Program, pointing out that the conferences were designed to provide for the direct interchange and discussion of practical working ideas on current problems, and "were never intended to provide merely a channel for the presentation of formal speeches." On the basis of these observations of and participation in the recent series of regional conferences, he urged that "all persons responsible for the planning of future conferences should make special effort to provide ample time for questions and a full discussion of the various topics on the program." President Tayler warned again about the tendency "to talk too much to ourselves," and urged that special efforts should be made to "draw into cooperative participation in the conferences representatives of electrical contractors, architects, and the many other professions having to do with lighting." He also drew attention again to the broadened membership service now being provided through the enlarged monthly publication ILLUMINATING ENGINEERING, and to the wealth of useful lighting data available in the many other publications issued by the Society and available from headquarters in New York.

PROGRAM

The technical program of the Conference was accommodated in four sessions, one held each morning and each afternoon of the two-day meeting.

At an organized group luncheon Tuesday noon, Chairman M. J. Davis of the Eastern Pennsylvania Chapter served as toastmaster. An interesting talk of historical nature was given by O. E. Day, Chief of the State Council for the Blind, Department of Welfare, Commonwealth of Pennsylvania. Mr. Day commented upon the development of electric lighting and other technical achievements in their relationship to the prevention of blindness or the relief of sufferers. In commenting upon the length of time that has elapsed in technical history between the birth of an idea and its general practical application, Mr. Day said: "... it is interesting to note from history that almost 75 years elapsed from the time the organometallic compound of tetraethyl lead first was produced until Midgely first put it into practical use ... almost 55 years elapsed from the time Edison invented the phonograph as a means of educating the blind before it was actually put to practical use for that purpose ... 50 years went by before Tesla reaped a poor harvest from Faraday's experiments of the early 1830's ... almost 60 years since Tesla dreamed up the fluorescent light idea; the practical application is just now coming into its own. ..."

Wm. S. Livingood, Secretary of the Commonwealth of Pennsylvania, also spoke briefly at the luncheon. He referred to the audience as "Lamplighters," and urged special effort on the part of each individual to go beyond the technical limits of his professional sphere and help to keep burning brightly the Lamp of Freedom, the Lamp of Education, the Lamp of Civil Liberties, and others of importance to human welfare.

The social program featured an informal dinner-dance, and a special tour for women guests, both on Tuesday. At the dinner-dance, I.E.S. Regional Vice-President Harry Grattan, Jr. served as toastmaster for the banquet, with President and Mrs. Lee Tayler as honored guests. Highlight of the evening was the program of songs and entertainment put on by "The Lamplighters" of Nela Park, Cleveland. Occupying a schedule from 9:30 a.m. until 2:30 p.m., the special tour provided for women guests included a trip through the Hershey Chocolate plant, and luncheon at the Hershey Community Inn.

At the opening technical session on Monday morning, Vice-President Harry Grattan, Jr., officially opened the conference with appropriate remarks before turning the session over to Chair-

man C. S. Woodside of the Capital Section who officiated for the technical program:

1. "Planned Lighting in Philadelphia," by C. C. Shotwell, Supervisor of the Lighting Section, Philadelphia Electric Company.

2. "Planned Lighting in Pittsburgh," presented by G. H. Maize of the Duquesne Light Company.

3. "Planned Lighting in Washington," by H. V. Oerting, Illuminating Engineer Potomac Electric Power Company.

4. "Planned Lighting in Eastern Pennsylvania," by J. M. Stedman, Commercial Sales Manager, Pennsylvania Power and Light Co., Allentown, assisted by B. D. Barr of the Metropolitan Edison Company at Reading.

At the Monday afternoon session, Chairman Harry Restofski of the Pittsburgh Section officiated with gavel and a time clock to monitor the following presentations:

1. "The Functions of I.E.S." by President Lee Tayler.

2. "Lighting—A World-Wide Interest" by A. A. Brainerd, President of the United States National Committee of the International Commission on Illumination.

3. "The Lighting of Museums and Other Public Buildings," by J. M. Ketch, Managing Engineer, Office and School Lighting General Electric Co.

4. "The Fleur-O-Lier Specification and Rating," by E. W. Lampert, Chairman Fleur-O-Lier Technical Committee.

For the school-lighting symposium which comprised the Tuesday morning session, the subject was approached from three widely different points of view with Chairman G. E. Shoemaker of the Philadelphia Section swinging the gavel:

1. "Prevalence of Defective Vision in Penna.," by Dr. Ralph C. Lamciano, Chief Ophthalmologist, Philadelphia Board of Education.

2. "Effect of Color in the Class Room," by Marshall Ziv, National Chemical and Manufacturing Company, Chicago, Ill.

3. "American Recommended Practice of School Lighting," by W. H. Kahler, Member of I.E.S. Committee on Lighting for Education.

Something new really was added at the Tuesday afternoon session in its competitive symposium on the topic "My Most Interesting Job." Chairman G. E. Shoemaker of the Philadelphia Section presided at this session:

1. "Relighting a Brewery Office," by C. H. Bronner of the Baltimore Section.

2. "The Big Palestra," by G. W. Wagner, Application Engineer, Lighting Application Section, Philadelphia Electric Co., representing the Philadelphia Section.

3. "Lighting a Stationery Store," by L. H. Cleary, Lighting Engineer, Washington, D. C., representing the Capital Section.

4. "A Unique Home Lighting Job," by H. J. Kretzberger, Lighting Representative, Pennsylvania Power & Light Co., representing the Eastern Pennsylvania Chapter.

5. "Relighting a Bank," by H. S. James, Lighting Engineer, Duquesne Light Company, representing the Pittsburgh Section.

Committees

IES'ers who missed the Harrisburg Conference missed something. The people whose planning and hard work were responsible for this situation were:

Conference Committee: H. Grattan, Jr., Capital Section, chairman; O. C. Nord, Eastern Pennsylvania Section, secretary; C. P. Newbraugh, Baltimore Section; J. P. Bachman, C. S. Woodside, Capital Section; M. J. Davis, P. H. Hildebrand, Eastern Pennsylvania Section; A. A. Brainard, P. R. Holmes and G. E. Shoemaker, Philadelphia Section; C. M. Crysler, A. Hampsey and H. Restofski, Pittsburgh Section.

Program: P. H. Hildebrand, Eastern Pennsylvania Section, chairman.
Finance: W. R. Robinson, Eastern Pennsylvania Section, chairman.
Local Arrangements: E. W. Kelsey, Eastern Pennsylvania Section, chairman.
Publicity: J. N. King, Eastern Pennsylvania Section, chairman.
Entertainment: R. D. Howe, Eastern Pennsylvania Section, chairman.
Registration-Reception: H. F. Carroll, Eastern Pennsylvania Section, chairman.

Lighting Service Forum

The interdependence of the many different elements and groups which make up the lighting industry, and the fundamental importance of a full and understanding co-operation among these in the development and application of more effective lighting, constituted the theme which stood out in the planned-lighting session. Each of the several speakers hit on these points in one way or another.

For example, Mr. Shotwell expressed the opinion that "... many well designed lighting installations actually go in as mediocre jobs, not because the original recommendation was not justified or because the prospect could not afford to buy it, but simply because of a lack of mutual understanding, respect, and just plain good business sense . . . consequently, many times it is the customer who is the real loser. . ." He described the planned-lighting programs of the Philadelphia Electric Company, the Atlantic City Electric Company, and the Delaware Power and Light Company. He mentioned in some detail the functioning of the Philadelphia Electrical Association in bringing about effective cooperation among manufacturers, wholesalers, electrical contractors, and utility lighting specialists.

Mr. Maize called attention to ". . . the confusion in the mind of the lighting customer, arising from the impact of the fluorescent lamp as a wholly new lighting source . . . and the further confusion arising from the tendency in too many instances for a lighting job to be approached on the basis of selling fixtures rather than of providing effective lighting. . . ." He described the program of the lighting industry in the Pittsburgh area, featuring among other things the slogan "get a plan from the man who plans." By means of a skit featuring the growth of an infant to a six-foot protegé through the consistent feeding of the "Pittsburgh formula," Mr. Maize dramatized the five points of the Pittsburgh program: (1) Team-

EAST CENTRAL Regional Conference entertained President and Mrs. Tayler at its annual banquet June 7. Shown at the head table are: seated, A. R. Hampey, Chairman-elect of Pittsburgh Section; Mrs. Lee Tayler; President Lee Tayler; Harry Grattan, Jr., Vice-President, East Central Region; Mrs. M. J. Davis; Mrs. C. S. Woodside. Standing, Paul H. Hildebrand, Chairman Program Committee; C. S. Woodside, Chairman Capital Section; Mrs. Paul Hildebrand and Mitchell J. Davis, Chairman Eastern Pennsylvania Section. (George Shoemaker, Chairman Philadelphia Section, was present but is not on photo.)

work and method; (2) industry training; (3) consumer education through lay organizations ranging from high-school groups to women's clubs, etc.; (4) advertising in local newspapers, not only to support sales personnel but to reach a broader market; (5) effective cooperation of the various elements of the lighting industry, through the Electric League of Western Pennsylvania."

Mr. Oerting pointed out that "a large bulk of the lighting installation work is being done by small and independent electrical contractors . . . hence this is the most promising field for cooperation and for education as to the value of joint efforts in promoting good lighting. . . ." In support of this contention he described an educational program put on by the Potomac Electric Power Company which brought a registration of 130 and an average attendance of 100 persons for a course in Lighting Application.

International Interest

The organization and functions of the International Commission on Illumination were explained by Mr. Brainerd who pointed out that "it does not in any way compete with the I.E.S., but rather supplements it by encouraging international exchange of ideas, bringing home new and valuable information, and explaining our viewpoints to Europeans and others . . . the need for an international lighting organization is just as apparent as the need for a national society. . ." Mr. Brainerd's talk appears elsewhere in this issue.

Public Buildings

Public buildings differ from commercial buildings, according to Mr. Ketch, "in that the architect of a public building assumes a much more active guiding position than with a commercial building, and sets a pace which the lighting engineer must try to keep up with." Mr. Ketch mentioned museums, churches, and libraries. He described the modern museum as being "not a storehouse, but a show place for public edification, for the putting on of a show, and with lighting problems accordingly. . . ." Once dependent principally upon daylight, Mr. Ketch reported that museums more and more are doing away with skylights because of the cost of heat loss through them and the cost of maintenance. He touched upon the use of polarized light, especially in wall cases to get away from reflections; also mentioned the use of color through the mixture of fluorescent and incandescent sources. With reference to churches, Mr. Ketch pointed out the necessity of designing the lighting installation to suit the peculiar requirements of the different major types of religious services. With reference to libraries, Mr. Ketch stated that ". . . for many years, libraries were regarded primarily as architectural monuments . . . usually provided no light for readings . . . now, people are coming to the conclusion that a library is the place to go to read . . . table lamps are on the way out, and we are entering an era of general illumination in libraries." Mr. Ketch discussed various problems involved, including methods of obtaining good lighting for library stacks.

Fleur-O-Lier Program

Mr. Lampert briefly traced the history of the Fleur-O-Lier program of specification and ratings back to its beginning, as a joint agency for establishing recognized standards of performance in the field of fluorescent lighting fixtures and associated equipment. He reported that today approximately 30 leading manufacturers specializing in commercial lighting fixtures are members of the Fleur-O-Lier program and summarized the basic purpose of this program: ". . . To sponsor specifications that assure mechanical, electrical, and illuminating excellence in lighting equipment. . . . To maintain a system and recheck by a recognized and impartial laboratory. . . To promote the cause of good lighting and the use of good lighting equipment."

"Now, with all this testing and checking, one thing was still lacking," stated Mr. Lampert, "and that was a simple method that would tell or describe, classify, and identify the various illumination characteristics of the fluorescent lighting fixture so that an engineer, architect, or utility man could specify a fixture as to its required performance and quality. . . . Consulting with other authorities in the lighting field and, guided by the Recommended Practices of the I.E.S., and making use of the extensive knowledge of the testing laboratories, the Fleur-O-Lier Technical Committee devised the Fleur-O-Lier Index System which:

1. Provides a simple and exact standardized formula which a specification writer may use to specify the illumination characteristics desired in an installation.

2. Provides a method of fixture identification and classification that will give information as to the lighting performance of a particular fixture, and that will provide an easy and certain way for the customer to know that he is getting the kind of lighting equipment recommended for his installation."

Mr. Lampert described the Fleur-O-Lier Index as being a code using letters and numbers to express and evaluate five classes of fixture performances:

Class 1. Fixture classification; the five basic types of fixtures as classified by I.E.S.

Class 2. Crosswise or side shielding.

Class 3. Lengthwise or end shielding.

Class 4. Brightness in the shielded zone.

Class 5. Mounting methods; pendants, surface, or recess.

"Thus," said Mr. Lampert, "Fleur-O-Lier specification and Index System enables the designer and engineer or utility man to prepare a layout and specification with a feeling of satisfaction and confidence that the fixture specified will give satisfactory service and the desired lighting performance. . ."

Defective Vision

In discussing the topic "Prevalence of Defective Vision in Pennsylvania," Dr. Lamciano reminded his audience that when a child is born it is far-sighted until approximately seven years of age, after which time it becomes near-sighted. On this basis, he emphasized that parents should not be too ambitious to have their children learn to read and write at very early ages, but should wait until the children's eyes are mature. He emphasized further that both parents and school authorities should see to it that children receive proper food and also have proper illumination both at home and at school.

Dr. Lamciano described the program of positive action that has been taken by the City of Philadelphia toward correction of defective vision in school children, under a 1945 Act of the Legislature of the Commonwealth of Pennsylvania which required all school districts in the State to conduct physical

examinations of pupils. In that first year, he reported, the Philadelphia School District appropriated only some $7,000 for the complete cost of eye correction for all pupils in the school district. By the school year 1948-1949, this amount had been increased to $100,000. Of the 300,000 pupils in the Philadelphia area, some 105,000 were examined this past year by competent ophthalmologists. Of this number, some 24,000 had ocular defects and 4,000 had either cross eyes or were suffering from the loss of one or both eyes. Dr. Lamtano stated emphatically that "prevention is far better than correction," and pointed out that proper nutrition and ample illumination are both effective measures.

Color in the Class Room

Mr. Ziv opened the discussion of his topic, "Effect of Color in the Class Room," by pointing out that 70 per cent of the energy in the human body is used to live, and that the remaining 30 per cent is used in the learning process. He described color as a wavelength of energy which quite often acts as a "trigger" to stimulate bodily energy. Mr. Ziv referred to Dr. Harmon's recent technique and noted that as a result of his studies it had been found that some 20 per cent of the children entering school had some physical defect; further, that this percentage increases to 40 per cent after two years, and after five years in school to the astounding figure of 80 per cent. He explained that by physical defects, he meant not only eye defects but other bodily defects including posture, and mentioned that Dr. Harmon had found no increase above the 20 per cent mark in children who did not go to school at all.

The fact that body posture or physical training could cause many other bodily defects was emphasized by Mr. Ziv. He mentioned also that Dr. Harmon's technique would indicate that most students afflicted with defective vision had been affected by high glare resulting from natural illumination. His discussion was concluded with a very complete discussion of and emphasis on the use of color in the classroom.

School Lighting

Mr. Kahler briefly reviewed the developments of recommended practices for school lighting from the first 1918 I.E.S. code on school building lighting to the latest revised code of recommended practices approved and adopted by the American Standards Association of 1948. Mr. Kahler urged the importance, as a public service, of bringing this valuable publication to the widest possible public attention. This is something that local sections and chapters can do to advantage.

"My Most Interesting Job"

The Harrisburg symposium embracing the competitive presentation of papers on the topic "My Most Interesting Job" represented a useful combination of a constructive program which embraced the entire region. During the year, the program provided for each section and chapter to stage a local competition among its members covering the description of lighting jobs which were considered by the individual contestant to be the most interesting or unusual one done by them during the year. The winner of each of the local contests became a participant in the regional contest, with corresponding opportunity for wider recognition.

At Harrisburg, Hugh James of the Pittsburgh Section won the regional award by his description of the relighting of a Pittsburgh bank. This was a progressive job involving four successive steps: (1) the accounting department; (2) the vault area; (3) the main banking floor; and (4) the directors' room. He described principally the installation in the main banking room where a combination of louverall sections and solid ceiling suspended about 17 inches below the original ceiling and 21½ feet above the floor provides 45 footcandles in the central public area, 60 footcandles in the rear of cashiers' counters, and 75 footcandles on cashiers' counters. The design pleasingly combines the use of fluorescent and incandescent sources in an attractive pattern arrangement. Mr. James' job description won him a Merit Award at the recent International Lighting Exposition competition in Chicago, and his presentation at Harrisburg won him the First Prize in the "My Most Interesting Job" competition.

Mr. Bronner of the Baltimore Section described the problems encountered in the relighting and general refurbishing of the office areas of a brewery. Consultation among the architects, consulting engineers, and lighting specialists resulted in the use of a louverall ceiling to obviate the construction of a false ceiling to hide exposed pipe and ducts. Fluorescent units were used.

Mr. Wagner described the relighting of the "Palestra" sports arena of the University of Pennsylvania, from a level of 3 footcandles to a job designed to produce 100 footcandles minimum for the taking of motion pictures of basketball games and other indoor sports.

The system is flexible, and can be operated at the minimum of 50 footcandles required for sport television, or the 30 footcandles for basketball practice and for the viewing of other indoor sports. In general, 1000- and 1500-watt units are mounted 50 feet above the playing floor.

Mr. Cleary described the project of relighting a Washington stationery store to provide levels ranging from 50 to 70 footcandles. In general, continuous rows of ceiling-mounted glass-enclosed fluorescent units were used. Readings taken after 200 hours of operation indicated an average of 74 footcandles over the main first floor sales area.

Mr. Krietzberger described the residential installation of flush-mounted ceiling units with prismatic lenses for the lighting of a collection of oil paintings in a living-room. The results were reported to be so satisfactory that the same type of installation was extended to the library in the same home.

Illuminating Engineering Reprints

To provide readers as well as authors with quantities of reprints of articles, it is planned to hold future issues of Illuminating Engineering in type for about four weeks following publication. Orders should be submitted to the Publications Office, Illuminating Engineering Society, 51 Madison Avenue, New York 10, N. Y. As the cost of reprinting varies with the number of pages and the quantity ordered, prices for a specific item will be submitted on request. While many authors follow the practice of getting a small quantity of reprints for their own use, the Publications Office does not in general have sufficient extra copies for possible continued demands.

Summary of Action at the Council Executive Committee Meeting, Philadelphia

The July meeting of the Council Executive Committee was called at Philadelphia on July 6. Present were President Lee E. Tayler, presiding; C. H. Goddard and Walter Sturrock, Vice-Presidents; E. M. Strong, Treasurer; A. H. Manwaring, General Secretary; A. D. Hinckley, Executive Secretary; and George T. Bogard, S. G. Hibben, C. C. Keller, G. E. Shoemaker, M. N. Waterman.

Membership

Favorable action on the report of the Board of Examiners resulted in the election to I.E.S. membership of 7 Members, 30 Associate Members and 6 Students. The July elections, together with other changes in membership result in the following tabulation of membership figures:

September 30, 1948		July 6, 1949
6516	Total Membership	6883
21	Members Emeritus	26*
45	Fellows	42
1406	Members	1523
4908	Associate Members	5048
136	Student Members	244

*Includes 5 Fellows of the Society.

Local Activities

In his report on the Local Activities Committee, Walter Sturrock, Chairman, noted that among other activities of this committee, the project to assign all areas in the United States and Canada to the territory of a Section or Chapter has now been completed. He reported that study is continuing on the possible redivision of the whole area into more than nine regions. In this connection it was the consensus of the Committee that the establishment of more Regional Vice-Presidents for the larger number of Regions would help stimulate activity and continued growth.

Two New Fellows

The General Secretary reported a favorable letter ballot by members of Council on the report of the Board of Fellows as submitted at the June Council meeting. Action taken to accept the report of the letter ballot elected to Fellow grade two distinguished Members of I.E.S. — Francis Chapin Breckinridge and Val J. Roper. Details of their election to Fellow are given elsewhere in this issue of the Telecast.

Bibliography on Blackout and Dimout Practices Available

A comprehensive bibliography of the blackout and dimout lighting practices during World War II has just been completed by the I.E.S. Special Committee on Wartime Lighting Practices During World War II, and is available on request at I.E.S. Headquarters. The special committee for this valuable project was appointed by the President of the Society in 1946 "to solicit, assemble and compile a record of studies and practices on dimouts, blackouts and defense lighting (including concealment, camouflage and other topics) related to World War II experience; and to file such a record in the I.E.S. Headquarters."

Such a record of both civil and military practice as covered by this bibliography has been assembled and is available for reference.

The committee selected the material from civic, military and private files in every section of the United States, Canada, Great Britain and Germany. No attempt has been made to evaluate the great variety of technical and other documents contained in this file, which is not intended to be inclusive but only to be representative of the wartime blackout and dimout lighting practice in these countries. However, to give future students of this phase of the war effort an overall engineering perspective, an engineering digest prepared by the past-chairman of the I.E.S. Committee on Defense (S. G. Hibben) has been included as an introduction to the bibliography.

The Special Committee which collected and assembled this file and prepared the bibliography were: O. P. Cleaver, Chairman, C. F. Cashell, C. I. Dwinell, S. G. Hibben, S. R. McCandless, Roy A. Palmer, Kirk M. Reid, F. J. Wellhouse and C. W. Zersen.

F. C. Breckenridge and Val J. Roper Elected Fellows of I.E.S.

The distinction of election to Fellow of the Illuminating Engineering Society has been approved for two prominent members of I.E.S. — Dr. Francis C. Breckenridge and Mr. Val J. Roper. Acting on the recommendation of the Board of Fellows, these two distinguished members were elected to Fellow grade by the Council Executive Committee at its meeting in Philadelphia on July 6.

Dr. Francis C. Breckenridge is at present a physicist in charge of lighting research for the Civil Aeronautics Administration, Optics Division of the National Bureau of Standards, Washington, D. C. Dr. Breckenridge's work for more than 25 years, as a scientific assistant with the U. S. Lighthouse Service and physicist with the Bureau of Standards, has resulted in valuable original work in illumination. He is well known for his original researches on the transmission of light through fog and the specification of colors. He developed the optical design of neon approach light in use by the C.A.A.; developed the design of optical and some mechanical aspects of the 24" beacon; contributed the technical basis of the original Airport Lighting Specification of the C.A.A., and did much original work on lighthouse and early aviation lighting equipment specifications. Dr. Breckenridge is the co-inventor of the traffic control projector and holds patents on the airplane position light.

Dr. Breckenridge has been a valuable member of the Society's Committee on Aviation Lighting, and for some 15 years served as its chairman. Many of his original papers on aviation lighting have appeared in the Society's Transactions.

In addition to his service with I.E.S., he is a member also of the U. S. National Committee of the International Commission on Illumination, for many years Director of the I.C.I. Secretariat for Aircraft Lighting and Aviation Ground Lighting. At the 1935 and 1939 sessions of the I.C.I., Dr. Breckenridge attended as an American delegate to the Congress, and has been the U. S. representative on technical com-

F. C. Breckenridge

Val J. Roper

mittees for many years, including chairman of the Liaison Committee on Inter American Lighting Affairs. He is a member of the American Physical Society, the Optical Society of America and the Institute of Aeronautical Sciences.

VAL J. ROPER, head of the Automotive and Aviation Lighting Section, Engineering Division of General Electric Co., Nela Park, Cleveland, Ohio, has for many years enjoyed the prestige of one of the leading technical authorities in the field of automobile lighting. He is the designer of numerous improved motor vehicle and aircraft lighting devices, including the sealed beam headlamp. For years, Mr. Roper carried out basic research of motor vehicle lighting requirements in the laboratory and on the road, creating for this purpose many new techniques and unique and extensive facilities, both mobile and indoors. He holds patents on headlamp units, apparatus for testing projection lamps, automotive incandescent lamps, light projectors, headlight indicators and numerous other automotive devices.

Mr. Roper served as technical consultant to the Lighting Committee of the American Motor Car Manufacturers throughout the development of the sealed beam headlamp program and the study of polarized headlighting. During World War II, under contracts with N.D.R.C., he directed important development work in the application of infrared and other radiant energy to military needs of the Army, Navy and Air Forces. It is interesting to note, in connection with Mr. Roper's prestige in the field of automotive lighting, that when European delegates found that he was not at first included in the list of American delegates to the 1948 meeting of the International Commission on Illumination in Paris, they made a last minute request that he be sent over by air to assist in the deliberations of Technical Committee 23b on Automobile Lighting. He played a most influential part in those deliberations which led to a joint American-European program of study looking toward greater uniformity of thought and practice in motor vehicle headlighting. Since that time specialists from three European countries have visited America to study the techniques employed in Mr. Roper's investigations of factors affecting seeing and safety with motor car headlights. In at least one of these countries, steps have been taken to duplicate some of his facilities.

Mr. Roper's many contributions to the Illuminating Engineering Society include many papers, particularly on motor vehicle lighting, published in the Transactions. He is a past-chairman of the I.E.S. Automotive Lighting Committee, and has served for many years as a member of the Aviation Lighting Committee also.

Lighting Courses Successful Local Projects

Of the subjects being discussed around the tables of local I.E.S. Boards of Managers this summer, probably the one of first importance is the detailed planning of Courses in Illumination. Almost all of the Society's Sections and Chapters have conducted highly successful lighting schools. For plans now underway, the experience of some of these may be of interest.

At least three of the Sections have "turned over" their courses to universities — the courses being conducted by

THE GAVEL which Glenn G. Boyd, retiring Chairman of the Chicago Section, received when he took office a year ago, was presented to him as a personal gift from the members of the Chicago Section at a recent meeting of the Board of Managers. The gift was presented to him by Ralph R. Cheney, Chairman-elect. Shown at the ceremony are: B. R. Lush, Secretary-elect of the Chicago Section; Mr. Cheney, Mr. Boyd, and O. B. Pederson, Vice-Chairman-elect.

I.E.S. Section personnel, the curricula being planned by the Section, and speakers obtained from I.E.S. members — but with all other details and chief sponsorship being the responsibility of the university.

New York University, for instance, is offering a "package" of lighting courses consisting of the Lighting Fundamentals and Advanced Illumination Design courses outlined and conducted by the New York Section, and the course in Practical Methods of Home Lighting planned and conducted by the Residence Lighting Forum of the New York Section.

The close cooperation between the Chicago Lighting Institute, Illinois Institute of Technology, and the Chicago Section of I.E.S. on foremost lighting courses, is of course, now a well-known institute. The Chicago Lighting Institute has recently offered a free course in the application of artificial light in amateur photography, cooperating in this with two local camera clubs. A similar course might be feasible as a Section or Chapter project, in cities where interest in photography is high.

A lecture series on modern architecture was a feature last spring of the Cleveland Section program. This was arranged by the Section's Educational Committee as a program for study and cooperation with an allied profession. Three evening lectures were held, featuring local architects as speakers.

The "younger" Chapters have also found a gratifying response to their well-organized courses. The Mother Lode Chapter in Sacramento, California, less than a year old, conducted an excellent course last spring, educating a wide variety of personnel from journeymen electricians to architects and federal engineers. Their course, as have others, distributed certificates upon completion of the course. They also followed the pleasant practice found successful in other I.E.S. meetings, of serving refreshments to promote friendly acquaintance among the students. Clark Baker, Jr., Educational Chairman of the Mother Lode Chapter, was the member responsible for this excellent job.

The Georgia Section used a neat trick to keep their members constantly alerted to the progress of their basic lighting course. A ruled box on each of their mimeographed meeting notices featured details of each of the seven lessons, as the course progressed. Their course extended over their entire year's program, with a session each month. This practice was apparently popular, since their attendance was consistently high. J. B. Browder headed the committee conducting the course.

Many of the Section and Chapter-sponsored courses have been outlined in detail in previous issue of IE — but a summary of the more successful features might include:

(a) Planning the course around the use of the IES Lighting Handbook, and distributing this as a basic text book.

(b) Featuring specialized lighting problems, with I.E.S. Lighting Data Sheets as fundamental literature.

(c) Clinics and forums on various phases of lighting practice.

The Society's Lighting Fundamentals Course outline, developed by the Lighting Education Committee, has of course been the foundation for the numerous successful lighting schools conducted by local Sections and Chapters. This book is available from I.E.S. headquarters at a price of $1.00 for a single copy, 75 cents in quantities of ten or more.

REPRESENTATIVES of winning companies in the 1948 Planned Lighting Awards contest pose with their prizes at the recent Edison Electrical Institute Annual Convention, at Atlantic City, N. J. Left to right, J. S. Schuchert, Duquesne Light Co., Pittsburgh, Pa., second prize in Commercial Lighting promotion. J. E. Mueller, West Penn Power Co., Pittsburgh, Pa., first prize in Residential Lighting. J. M. Guillory, New Orleans Public Service, Inc., New Orleans, La., first prize in Commercial Lighting. H. M. Sawyer, Chairman, E.E.I. Prize Awards Committee. J. M. Stedman, Pennsylvania Power & Light Co., Allentown, Pa., with the Grand Prize for overall lighting promotion. L. M. Holmes, Dayton Power & Light Co., Dayton, Ohio, second prize in Industrial Lighting. H. H. Brenan, Pennsylvania Power & Light Co., second prize in Residential Lighting. Clarence Schoch, Pennsylvania Power & Light Co., first prize in Industrial Lighting. Awards totaling $1,400 were made for outstanding programs and accomplishments in Planned Lighting, including lighting education and sales-promotion.

IT SEEMS TO ME

The Fallacy of the Louverall Ceiling

To the Editor:

The paper was meant to be provocative, and apparently it was successful in this respect if in no other. The group of letters to the editor, printed in the May and June issues of ILLUMINATING ENGINEERING, come from strong champions of the louverall ceiling. I have read the varied comments and am grateful for them.

Let me again state the basic idea of the paper: in the conventional fluorescent-lamp, louverall system, *a 3:1 helios ratio cannot be obtained, the ratio being 50:1 or more. This high helios ratio tends to produce reflected glare.*

It seemed unnecessary to mention in the article that if all surfaces in the room were perfectly diffusing, there would be no reflected glare; but typical classrooms, offices, and drafting rooms contain many objects that are far from perfectly diffusing. It seemed also unnecessary to mention that if there is no bright source above the

louver (as in excellent designs of Howard Sharp) there will be no reflected glare. In the conventional louver system, irrespective of what material is used for the louvers or how they are constructed, *there is a high helios ratio because of the high helios of the lamps themselves.* This fact is obvious and constitutes the fundamental weakness of the louverall ceiling.

The secondary questions of the relative coefficients of utilization for luminous ceilings and louverall ceilings may be investigated by the interflectance method. It is on this basis that generalizations can be made from meager data. I might point out that both Mr. Benson and I obtain less light from matte white cubical louvers than from paper panels. It is also true that these materials do not produce the highest possible coefficients of utilization, but may be surpassed by translucent plastics. Clear Plexiglass, for instance, would give almost as high a coefficient of utilization as bare lamps. But it would not control the light.

The cubical shape of louver tends to trap a surprisingly large amount of light, while the shallow wide luminous panel tends to transmit a large amount of light.

The question of dust collection can also be investigated by the interflectance method. Tests show that more dust collects on vertical surfaces (louvers) than on horizontal surfaces facing downward.

I venture to predict that ten years from now, during the year 1959, not a single louverall ceiling will be installed in office, classroom, or drafting room in the United States! The fad will have passed into history.—DOMINA EBERLE SPENCER, *Assistant Professor, Dept. of Physics, Brown University, Providence, R. I.*

"Slope-Line System" Adopted as Landing Aid for Aircraft

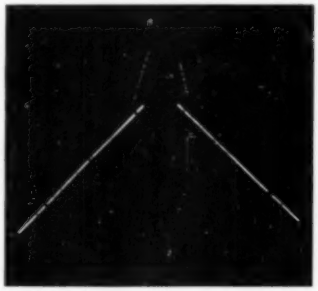
The landing of aircraft under atmospheric conditions of severely limited visibility is probably one of the most critical and far-reaching problems of the entire aviation industry. Consequently, there has been an enormous amount of developmental and experimental effort put forth in recent years in the attempt to devise a practical and effective system of guidance for the pilots of incoming aircraft requiring landing facility under such conditions. It has been considered by authorities that such an approach-light system should give a pilot simultaneously six important bits of information, and give them to him accurately: (1) his lateral position with reference to the center line of the landing strip; (2) his vertical position with reference to the ground; (3) an indication of the distance he has traveled along the approach path; (4) an indication of the direction of his travel with reference to the proper direction for the approach path; (5) an indication of the attitude of the aircraft with reference to roll; and (6) a positive identification of approach lights in contradistinction to other lights.

One of the experimental slope-line light units.

On the basis of extensive and competitive tests of various approach-light systems, the Aircraft Committee for the Munitions Board on April 5, 1949, approved the slope-line approach-light system as the only United States standard high-intensity system for both military and civilian use. Previously, in November, 1948, the Air Force-Naval-Civil Sub-Committee on Visual Aid to Aviation had voted to adopt the slope-line system as the new standard. Some 600 or more approaches were made at the experiment station with the various types of lights and under varying weather conditions found, to a visibility of one-sixteenth mile and zero ceiling. While some of the other systems equalled the guidance given by the slope-line system on one or more of the six criteria previously mentioned, and one system gave excellent identification although failing on the other points, it has been reported that it was the unanimous opinion of test personnel that, on the whole, the slope-line system was superior to any of the other systems tested. The slope-line system was the only one tested that attempted to give vertical guidance, and this it is reported to have done very well. The tests were made at the Landing Aids Experiment Station at Arcata, California, a location where heavy fogs prevail through a considerable portion of the year. Thus, it was possible for the lighting systems to be tested under unusually adverse weather conditions.

Typical slope-line light pattern as seen by pilot from various approach positions, each pattern conveying a readily interpretable message for correction of aircraft position.

The development of the slope-line landing system has been sponsored by the Office of Technical Development of the Civil Aeronautics Administration. It is of some especial interest



Slope-line light pattern as seen at night by a pilot on course and in proper position on glide path.

to note here that the idea of the slope-line system was conceived by two long-time I.E.S. Members, H. J. Cory Pearson, and A. J. Sweet (deceased), and developed under their guidance. The general features of the system were described in a paper "Visual Aids for Use in Restricted Visibility" by H. J. C. Pearson, which was published in the July, 1948 issue of ILLUMINATING ENGINEERING. In short, the system consists of two 3000-ft rows of light units, the rows being widely spaced at the outer end and converging to come within the limits of runway width at the end of the runway. Each of the lighting units is 14 feet long and made up of sealed-beam lamps equally spaced. These units are mounted at 45° with the horizontal ground line. They are installed in pairs, at intervals of 100 feet along the extended runway center-line, and oriented to point at the descending ideal glide path line where the path crosses the line connecting that pair of units. Thus, all units in each row lie in a single plane which intersects the horizontal at 45°. The planes of each row intersect each other at right angles along the "ideal glide path" and the geometry of the installation is such that this ideal glide path slopes to touch the runway at a point about 1100 feet from the outer end. The theory of the system is that when this installation is seen by the pilot of an aircraft properly located on the ideal approach glide path, the two rows of light units are seen as two straight lines which converge toward the desired point of ground contact. When the aircraft is in any other position, the two rows of units will form visible patterns which are peculiar to that position and which lend themselves readily to accurate interpretation. These points are amplified by the accompanying illustrations.

Numerous refinements have been worked out since the initial experimental installation at Arcata. This has included the development of a new 250-watt, 12.5-volt sealed-beam lamp about 6 inches in overall diameter, having a peak candlepower of about 80,000 and a horizontal beam spread of approximately 45°. This lamp is now the CAA standard and will be used in the slope-line approach light system now being planned for various airfields in the United States. Immediate installations are reported to be planned for Idlewild International Airport in New York City, Washington (D. C.) National, and for airports at Chicago and Los Angeles with other installations following later.

Maritime Chapter Celebrates Charter Night

The Maritime Chapter became a full-fledged member of the Illuminating Engineering Society at a special Charter Night meeting held May 30 at the Admiral Beatty Hotel, Saint John, New Brunswick. Guests of honor were Duncan M. Jones, Canadian Regional Vice-President, who presented the Charter certificate to the new Chapter's chairman, Joseph Thomas, Chairman of the Montreal Section, and Robert C. Thomas, Chairman of the Montreal Extension Committee, both of whom were instrumental in the formation of the new Canadian chapter. D. Roland Webb, of Saint John, the Maritime Chapter chairman, presided at the special meeting and accepted the Charter from Mr. Jones.

In presenting the Charter, Mr. Jones urged the Maritime Chapter members to be proud of their organization, the work of which he said played a part in the lives of nearly every person and many professions. He emphasized that the Society's aims, carried out through its new Chapter, were entirely professional and on a high plane.

Other speakers at the charter ceremony were E. W. Patterson, mayor of Saint John, Robert C. Thomas, who reviewed the beginning and growth of the chapter, and Joseph Thomas, chairman of the Montreal Section, who told the members that acceptance of their charter brought many responsibilities. He said the new branch of I.E.S. must carry on the prestige which has been developed in other districts and he saw the organization as a great asset to the community.

The Chapter's by-laws, drawn up at a meeting in Moncton, were adopted by the meeting, as was the slate of officers who will hold office until October 1950.

Officers of the new Maritime Chapter are: Chairman, D. Roland Webb; Vice-Chairman, Victor Oldham, Halifax; Secretary, Henry Lushington, Saint John; Treasurer, W. Blair Bass, Saint John.

About People

Leonard V. James, a Fellow of I.E.S., and illuminating engineering consultant for the Lamp Department General Electric Co., Chicago, has retired to inactive status with his company as of June 30. Prior to his joining General Electric some 25 years ago, Mr. James was a member of the electrical engineering faculty of the University of Illinois. Education has played a prominent part in Mr. James'

MARITIME CHAPTER receives Charter at special ceremony held May 30 at the Admiral Beatty Hotel, Saint John, New Brunswick. Receiving the Charter, center, is D. Roland Webb, Chairman of the new Chapter; presentation was made by Duncan M. Jones, Canadian Regional Vice-President. Officers and guests shown are, left to right, N. Lushington, Secretary, R. C. Thomas, Montreal Section, Mr. Webb, Mr. Jones, J. Thomas, Chairman, Montreal Section, and Blair Bass.

L. V. James

invaluable service to the illuminating profession and it was largely through his efforts that one of the first lighting courses was organized in Milwaukee in 1922. The interest he developed in lighting education led also to the development of the Chicago Lighting Institute which was opened in the spring of 1930. Mr. James was a member of the committee on management and the technical committee, and chairman of the committee on lighting education of that organization, during all of these years.

Mr. James has long been a member of the Illuminating Engineering Society, serving as Regional Vice-President of the Midwest Region, as chairman and member of numerous committees and as an officer for the Chicago Section. Perhaps his outstanding job for I.E.S. has been as chairman of the Committee on School Lighting, which prepared the 1948 revision of the American Standard Practice of School Lighting.

Mr. James plans to continue in lighting work as consultant, from his address at 437 Sixth Avenue, La Grange, Illinois.

Carl J. Jensen, lamp engineer with the Westinghouse Electric Corp. Lamp Department, has been elected chairman of the Committee on Lighting Education of the Chicago Lighting Institute. He succeeds Leonard V. James, who served in this same capacity for the past nineteen years until his retirement from the General Electric Co. on June 30. Mr. Jensen has been a member of the Commercial Engineering, Design Engineering, Works Engineering, Advertising and Manufacturing Department of Westinghouse for the past twenty years.

OBITUARY

John H. Kurlander, head of the projection, photographic, and miniature lamp section of the commercial engineering department at the Westinghouse Lamp Division in Bloomfield, N. J., died of a heart attack at his Nutley, N. J., home on June 24.

Born and reared in Trenton, N. J., Mr. Kurlander graduated from Drexel Institute in Philadelphia with a Bachelor of Science degree in Electrical Engineering. In 1920 he joined the Edison Lamp Works in Harrison as a lighting engineer and six years later became chief engineer of the Brenkert Light Projection Company in Detroit. He became associated with the Westinghouse Lamp Division in Bloomfield in 1929.

During World War II Mr. Kurlander developed a gunsight lamp which eliminated the blind spot American airmen encountered in firing at enemy planes which were diving out of the sun. His peacetime developments included the device that produces either a spot of light or a flood of light from an ordinary hand flashlight; a blue bulb photoflash lamp emitting invisible, unobtrusive light; black light illumination for airplane instrument dials; and colored filter glass for automotive turn signals, preventing "ghost" signals caused by reflections of sunlight. His early work with photoflash lamps also resulted in the design of such a lamp to function dependably with mechanical camera shutter synchronizers.

In addition to his long-time membership in the Illuminating Engineering Society, Mr. Kurlander was active also in the Society of Motion Picture Engineers, which organization he served as Secretary from 1930-1937. He was also a member of the Society of Automotive Engineers and the American Optical Society.

Peter C. Neale, associated with the Cleveland Electric Illuminating Company of Cleveland, Ohio, for 23 years, died June 23 at his home in Solon, Ohio. Mr. Neale's loss will be felt severely by the Cleveland Section of I.E.S., where he has been an active committee member or officer continuously for more than ten years. He was currently serving as historian for the Section.

ONE OF THE most brilliantly lighted parking lots in New England is this municipal parking lot in Manchester, New Hampshire. Uniform, high-intensity illumination without shadow is provided by 16,000-lumen mercury-vapor luminaires mounted on ornamental metal standards. The engineering layout was drawn up jointly by J. L. Caplin of the Public Service Co. of New Hampshire, and H. E. Wilson, General Electric Co., in cooperation with Ernest W. Graupner, city engineer, and the Aldermanic Traffic Committee of Manchester. (Winter scene is with malice aforethought. Ed.)

Mr. Neale was also active in national Society affairs, serving for several terms as a member of the Committee on Lighting Service, the Lighting Service Forum and the Committee on Lighting Data Sheets.

The Hamilton Ontario Chapter has reported the loss of its Chairman in the death on June 7 of **Walter Bennie** — its present and Charter chairman. Mr. Bennie took an active part in the formation of an I.E.S. Chapter in Hamilton, Ontario, where he had for a number of years promoted the Society's aims as a member of the nearby Toronto Section. Proprietor of the Bennie Electric Co. in Hamilton, Mr. Bennie was a past-president of the Hamilton Association of Electrical Contractors and the Ontario Electrical Contractors Association. In 1946 he was elected to represent the latter organization on the directorate of the Construction Safety Association of Ontario. From 1942 to 1945 Mr. Bennie was commanding officer of the 153rd Delta Squadron of the Air Cadets (Canada), and served overseas in World War I also, with the Canadian Expeditionary Forces in France. In addition to his leadership in I.E.S. affairs in Hamilton, Mr. Bennie was a member of the Hamilton Chamber of Commerce and of the board of the Electrical Service League in Toronto, as well as a number of civic associations in Hamilton.

Basil G. Kodjbanoff, retired vice-president and manager of the Eastern Division of the Benjamin Electric Mfg. Company, died June 8 in New York City after a two-month illness. "Kodj," as he was known to the electrical industry, was born in what is now part of Yugoslavia, coming to the United States when he was 16 years old. After graduation from Lehigh University (engineering), Mr. Kodjbanoff joined the Holophane Glass Company, later joining the Benjamin Electric Mfg. Company in its New York offices.

NEW MEMBERS

At the meeting of the I.E.S. Executive Committee held in Philadelphia on July 6, 1949, the following were elected to membership:

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Associate Member:

Matten, C. William, G & M Fluorescent Lighting Service, Corpus Christi, Texas

BALTIMORE CHAPTER

Associate Member:

Smith, James D., General Electric Co., Baltimore, Md.

CAROLINAS CHAPTER

Associate Members:

Myers, Frank B., Salem Electric Co., Winston Salem, N. C.

Stanford, E. M., Sylvania Electric Products, Inc., Washington, D. C.

CENTRAL NEW YORK CHAPTER

Associate Member:

Pierce, Robert M., Langdon & Hughes Electric Co., Inc., Utica, N. Y.

CLEVELAND SECTION

Member:

Scheid, Harry H., The Sherwin-Williams Co., Cleveland, Ohio

Associate Members:

Howard, Roy M., Midwest Sales Co., Cleveland, Ohio

Leighton, Kaye A., General Electric Co., Nela Park, Cleveland, Ohio

CHICAGO SECTION

Associate Members:

Grevelius, Curt W., Benjamin Electric Co., Des Plaines, Ill.

Peterson, Arthur J., Butler Brothers, Chicago, Ill.

Westerberg, Oliver D., Commonwealth Edison Co., Chicago, Ill.

CONNECTICUT SECTION

Member:

Carpenter, William P., The Superior Electric Co., Bristol, Conn.

Associate Members:

Benjamin, Russell W., Jr., United Illuminating Co., New Haven, Conn.

Colville, J. R., Jr., General Electric Co., New Haven, Conn.

Fratus, John V., Jr., Connecticut Light & Power Co., Essex, Conn.

CORNHUSKER CHAPTER

Associate Members:

Billmire, Robert W., Iowa Power & Light Co., Council Bluffs, Iowa

Davis, Thomas Holman, Westinghouse Electric Supply Co., Omaha, Neb.

DOMESTIC NON-SECTION

Associate Member:

Byars, Bruce, Tennessee Valley Authority, Wilson Dam, Ala.

FOREIGN NON-SECTION

Associate Members:

Broussard, Thomas G., Philippine Electrical Mfg. Co., Manila, P. I.

Carenzi, Mario, Selenia, Industria Lampade Fluorluminescenti, Via Francesco Nullo N. 8, Milano, Italy

Grover, L. R., Ambala Electrical Development Div., 28 Park Road, Ambala Cantt., East Punjab, India

Hong, Elizabeth K. H., Bureau of Sight Conservation and Work with the Blind, P.O. Box 1362, Hilo, Hawaii

McElroy, James P., Amerbel, S.A., 60 Ravenstein, Shell Bldg., Bruxelles, Belgium

EASTERN PENNSYLVANIA CHAPTER

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Bock, George R., Westinghouse Electric Supply Co., Allentown, Pa.

Brown, John L., Westinghouse Electric Supply Co., Allentown, Pa.

Ciesielski, Chester, Reading Tube Corp., Reading, Pa.

Long, Gordon W., Bull Dog Electric Products Co., Lincoln Park, Pa.

Pretzman, Richard J., Raub Supply Co., Lancaster, Pa.

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Yundt, George E., IV, 16 S. 6th St., Allentown, Pa.

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McGee, William L., Florida Power & Light Co., Fort Lauderdale, Fla.

GEORGIA SECTION

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Edwards, W. L., 824 North Highland Ave., N. E., Atlanta, Ga.

Associate Member:

Poage, J. D., Westinghouse Electric Corp., Chamblee, Ga.

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Field, B., Wood, Alexander & James, Ltd., Hamilton, Ont., Canada

HEART OF AMERICA SECTION

Associate Members:

Thorsell, Carl W., Tom Fielder Co., Kansas City, Mo.

Uhl, Robert J., Kansas State College, Manhattan, Kansas

IOWA SECTION

Associate Members:

Galbraith, Melvin H., Approved Lighting Service, Cedar Rapids, Iowa

Robinson, Bertrand L., B. L. Robinson & Co., Burlington, Iowa

MARITIME CHAPTER

Associate Members:

McCarthy, D. J., Canada Electric Co., Amherst, Nova Scotia, Canada

Continued on page 18A

BOOKS AND PAMPHLETS

A comprehensive theatre engineering handbook, detailing the physical requirements of the motion picture theatre from blueprint to curtain time and beyond, has just been published by the Society of Motion Picture Engineers. Entitled *The Motion Picture Theatre — Planning and Upkeep*, it presents in non-technical language a wealth of data on numerous phases of theatre design, construction, modernization, and maintenance under eight major headings: Physical Construction, Auditorium Design, Ventilating and Air Conditioning, Acoustics, Lighting, Floor Coverings, Promotional Display and Television. The book is designed as a reference work for all those concerned with the economics of motion picture exhibition, including lighting engineers in this field. The book is priced at $5.00, and is available through the offices of the SMPE, 342 Madison Ave., New York, N. Y.

Germicidal Sterilamps and Their Application **is a recent 9-page pamphlet describing the germicidal lamp, its purpose and application, released by Westinghouse Electric Corp. The introduction outlines the purpose of germicidal ultraviolet and basic facts regarding it, including what bacteria it will kill, amount of exposure necessary, precautions and reflections. Types of lamps are described, together with their radiation characteristics, distribution, temperature, concentration of ozone, metering and maintenance. It is available from the Westinghouse Electric Corp., Bloomfield, N. J.**

Fatigue and Impairment in Man, **by Howard Bartley and Eloise Chute (McGraw-Hill, 1947) is a comprehensive analysis of current thinking on the subject of fatigue. However, the book is highly technical and would be of interest only to physiologists, psychologists, and lighting engineers concerned with the relationship between light and vision. Only two of the twenty chapters are at all related to vision. Throughout the book the authors emphasize the difference between impairment and fatigue. "Impairment is seen as referring to the condition of tissue, which is directly discovered only by physiological and biochemical analyses, whereas fatigue is seen as an expression of the organization of the whole organism, which can be described only in personalistic terms." They state that work output is not a valid measure of either fatigue or impairment. Chapter IX — Conventional Visual-Fatigue Studies, is an excellent summary of sensory, ergographic, symptomatic, ease of seeing, and conflict methods of studying visual fatigue. One section of Chapter XVI— Personal Factors in the Work Situation, deals with "work that puts heavy demands upon vision and in which visual deficiencies become crucial." Visual Performance and Fatigue (Chapter XVII) relates to vision as it participates in personal conflict and contributes to fatigue. This chapter is divided into the following major sections: Gross Organism-Environment Relations that Lead to Frustration; Geometry, Image Formation, Visual Perception and Oculomotor Activity; The Motor Factors of Vision. Price of the book is $5.50 per copy.**

Careers in Engineering and Science **—a career booklet. This publication has been edited with the primary aim of giving a simple and direct presentation of the opportunities for professional training in college. It represents a notable departure from the conventional college catalog. An endeavor has been made to meet directly the point of view of high school students and those adult leaders who work with young men.**

The booklet gives complete details and information concerning admission to college. At the same time it does not seek to be too technical, it omits the procedures and regulations which are not essential to the prospective student. At the outset emphasis is placed on the need for making a personal appraisal and of giving careful consideration to the important step of choosing a career and choosing a college. An attempt is made to answer the questions: "What are Engineering and Science" and "Who Should Study Engineering and Science."

Throughout the booklet an effort has been made to give an intimate picture of the everyday activity in the classrooms and laboratories of a typical engineering college. While the illustrations of necessity reflect activities at one school, the point of view has been kept general so that this publication may be of assistance to young men of wide interests.

Careers in Engineering and Science **is available from the Polytechnic Institute of Brooklyn, 85 Livingston St., Brooklyn, N. Y.**

The Electric Lamp Industry: Technological Change and Economic Development from 1800 to 1947, **by Arthur A. Bright, Jr. (The Macmillan Co., 1949, price $7.50, is one of a series of studies of the economics of science and engineering undertaken at the Massachusetts Institute of Technology.**

In the preface Mr. Bright states, "Although the major developments in electric lighting are discussed more or less chronologically, I have tried to effect a compromise between a straightforward historical approach which would reserve all conclusions to the end, and a topical approach which would introduce the necessary data and evaluate the various factors as it went along. Accordingly, I have divided the history of electric lighting into four periods, each of which is discussed in considerable detail. Interpretations and minor conclusions are introduced into the historical presentation, and summaries collect the principal facts and conclusions at the end of each of the later groups of chapters. . . . Although the primary purpose of this study is to analyze the factors which influence technological progress, I hope that the story of the electric-lamp industry will also be of interest. . . . I do not know of any other analysis of the lamp industry with so broad a scope or such a long historical sweep."

Forty-three illustrations provide a pictorial history of lamps from the 1820 de la Rue lamp to equipment for exhausting and basing modern fluorescent tubes. The forty-five tables include data on types available, specifications, prices, life efficiencies, producers, and sales of lamps over a period of almost 150 years. The list of tables and illustrations and many references will be of interest to anyone interested in the history of electric illumination.

Discharge Lamps for Photography and Projection, **by H. K. Bourne — published by Chapman & Hall Ltd., London, 1948; 424 pages, 45 tables, 186 illustrations. This is an extensive presentation of the physical and electrical characteristics of many types of light sources. Although the book was written particularly for those interested in photography, scarcely any of**

the lamps described are restricted to photographic applications. The data given are broad enough to be useful to all engineers dealing with intense light sources. Much of the material presented is not in readily available form in this country. Lamps treated in detail are summarized below:

Tungsten Filament: projector, flood, spot.
Carbon Arc: low intensity, high intensity, "white flame," Pointolite.
Mercury Vapor: high pressure, water-cooled, compact source, low pressure.

Photoelectricity and Its Application, by V. K. Zworykin and E. G. Ramberg. Published by Wiley & Son, Inc., 1949; price $7.50. This volume replaces the 1934 *Photocells and Their Application*, by Sworykin and Wilson. The first half deals with the theory (practical rather than mathematical) and manufacture of photosensitive devices, and the last with their applications. All types of photoelectric devices are discussed from multipliers and rectifiers to television camera and picture tubes. However, in general, the book is a bit heavy for illuminating engineers. A very small percentage of the 494 pages discusses cells or circuits for light measurement or light control. Chapters, parts of which might be of interest to lighting personnel, are: Chapter 12: Photocell Circuits and Amplification. Chapter 14: Photoelectric Measuring Devices. Chapter 19: Miscellaneous Applications of Photoelectricity.

Planning the University Library, A Summary of Discussions by Librarians, Architects, and Engineers, edited by John E. Burchard, Charles W. David, and Julian P. Boyd; published by the Princeton University Press, 1949; price $2.50. This book is a summary of the discussions held by the Cooperative Committee on Library Building Planning from 1944 to 1948. This group, financed by funds from the Rockefeller Foundation and composed of architects, engineers, and librarians and other representatives from fifteen colleges and universities, met to exchange their experience, ideas, and knowledge of university libraries. The result is not a rigid set of specifications because the library depends upon the size of institution, the kinds of students it has, and the fields of knowledge which they study. The book is more of a check-list, discussing most of the problems which arise in planning such libraries, and the pros and cons of their solutions. The following indicates the topics covered:

Chapter 1: The Library in the University—a discussion of the relationships between the library and the rest of the university.
Chapter 2: Problems of Policy and Administration—deals with growth and organization of the library.
Chapter 3: Desirable Space Arrangements.
Chapter 4: Stack Arrangement and Construction.
Chapter 5: Air-Conditioning.
Chapter 6: Modern Illumination—reviewed in detail below.
Chapter 7: Technological Problems and Trends.
Chapter 8: The Librarian and the Architect.
Chapter 9: Library Planning: A Bibliographical Essay.

Library lighting has always been of concern to architects and librarians, but proper illumination of such buildings is infrequently achieved. In the chapter on illumination, brightness contrasts are discussed and the usual recomendations made. "How much light?" proved to be such a controversial issue that no fixed levels are recommended. The Committee urges "that each problem be given individual study." The level of illumination is less important than the brightness distribution. They stress the importance of lighter furniture and room decor. A minimum light source shielding of 18° above the horizontal line of vision is specified, with 20° to 30° listed as preferable. There is a rather lengthy discussion of incandescent lighting versus fluorescent. The Committee brings out that light from windows cannot be depended on, and that the proper luminaire for any application depends upon the particular room. They arrived at no satisfactory conclusions regarding stack lighting. For carrels they are opposed to individual desk lamps. This chapter is concluded by comments on the foregoing and a table of specific recommendations by Moon and Spencer are summarized below:

Ceilings—"White (not off-white)"—80 per cent reflectance.
Walls—50 per cent reflectance.
Floors—30 per cent reflectance.
Desk tops and other furniture of comparable size—30 per cent reflectance.
White venetian blinds; to be drawn at night.
Twenty footcandles average illumination at desk level. Maximum luminaire brightness three times that of paper on the desk.

The Effect of Age and Illumination Upon Visual Performance with Close Sights, by H. C. Weston, British Journal of Ophthalmology, September, 1948. This paper is an analysis of experimental data showing the decline in visual perception with age. Subjects in five age groups (24-28; 29-33; 34-38; 39-43; and 44-48) performed visual tasks involving the perception of small detail at six different values of illumination from 0.5 to 500 footcandles. The tests were given twice, separated by an interval of five years. The subjects were required to distinguish one particular orientation of Landolt ring from groups containing eight positions, and the tests were repeated with three sizes of rings. (The intermediate size corresponds approximately to the size of detail in newsprint.) By means of special test sheets the time required for manual action was determined and all data were corrected to give the actual discrimination time.

All the results show decline of visual performance with age. The decline investigated refers not to the resolving power of the eyes, but to the quickness of perception, a visual function not evaluated by clinical tests. Except at the lower values of illumination, the rate of decline is fairly constant for each size test object (5 per cent per year for the two larger rings), increasing somewhat more rapidly in the last age group tested. The greatest difference between age groups occurred for the most difficult visual task. Varying the illumination has a more marked effect upon visual performance as age advances. A change from the lowest to the highest illumination tried increased the performance of the youngest subjects only by 18 per cent, but increased that of the oldest fourfold. After a lapse of five years no group gave the same performance at the highest illumination as it formerly did at the lowest illumination, showing that for this type visual task any considerable advance in age cannot be fully compensated by any reasonable adjustment in illumination level.

The I.E.S. Guide for Testing Procedures, published in July I. E. is available now in reprint form from the Headquarters Office, 51 Madison Ave., New York 10, N. Y. Price, $1.00.

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Toronto Section—Canadian Region

CHAIRMAN—H. CECIL JONES, Canadian General Electric Co., Ltd., 212 King St., W., Toronto 1, Ont., Canada.
SECRETARY—DOUGALD W. PATTERSON, Amalgamated Electric Corp., 384 Pape Ave., Toronto, Ont., Canada.

Twin City Section—Midwestern Region

CHAIRMAN—JOHN O. KVALSTEN, Kvalsten Electric Co., 110 S. Fourth St., Minneapolis 1, Minn.
SECRETARY—R. H. HAMILTON, 5336 Drew Ave. S., Minneapolis, 10, Minn.

Utah Chapter—
South Pacific Coast Region

CHAIRMAN—J. VERNON SHARP, Sharp Electric Co., 128 S. State St., Salt Lake City 1, Utah.
SECRETARY—HAROLD R. TRIPP, Utah Power & Light Co., P.O. Box 899, Salt Lake City 10, Utah.

Western New York Section—
Great Lakes Region

CHAIRMAN—B. ALFRED THOMAS, General Electric Co., 901 Genesee Bldg., Buffalo 2, N. Y.
SECRETARY—RAYMOND P. CONNORS, 778 Starin, Kenmore, N. Y.

Winnipeg Chapter—Canadian Region

CHAIRMAN—EDMUND F. WILSON, 196 Balmoral St., Winnipeg, Man., Canada.
SECRETARY—T. W. BIRT, Winnipeg Electric Co., Electric Railway Chambers, Winnipeg, Man., Canada.

LOCAL REPRESENTATIVES

Canadian Region

Calgary, Alberta—H. J. McEwan, Canadian Westinghouse Co., Ltd.

Halifax, Nova Scotia—Victor Oldham, Canadian General Electric Co., Ltd.

London, Ontario—W. S. Hardman, Service Lamp Co., Ltd.

Moncton, New Brunswick—W. F. McElman, P. O. Box 404

Quebec, Quebec—G. A. Watters, Quebec Power Co.

St. John, New Brunswick—D. Roland Webb, The Webb Electric Co.

Windsor, Ontario—W. A. Shaw, Windsor Utilities Commission, Hydro Div.

Winnipeg, Manitoba—Edmund F. Wilson, Northern Electric Co., Ltd.

East Central Region

Allentown, Pa.—Francis E. Glick, Pennsylvania Power & Light Co.

Altoona, Pa.—Robert J. Nophsker, Pennsylvania Electric Co.

Atlantic City, N. J.—William S. DeHaven, Atlantic City Electric Co.

Bellaire, Ohio—C. L. Bullock, Ohio Power Co.

Bethlehem, Pa.—E. W. Halteman, Pennsylvania Power & Light Co.

Blacksburg, Va.—Claudius Lee, Virginia Polytechnic Institute

Camden, N. J.—James H. McQuestion, Public Service Electric & Gas Co.

Charlottesville, Va.—L. L. Holladay, 434 Brandon Avenue

Easton, Pa.—D. A. Wismer, Metropolitan Edison Co.

Erie, Pa.—Joseph L. Warfel, Pennsylvania Electric Co.

Hanover, Pa.—Edward H. Blettner, Metropolitan Edison Co.

Harrisburg, Pa.—Richard D. Howe, R. D. #2

Hazleton, Pa.—Howard J. Kreitzberger, Pennsylvania Power & Light Co.

Johnstown, Pa.—Howard E. Ross, R. D. #4, P. O. Box 324

Lancaster, Pa.—Ford M. Gochenauer, Pennsylvania Power & Light Co.

Lebanon, Pa.—Charles C. Russell, Jr., Metropolitan Edison Co.

Lexington, Va.—J. S. Jamison, Jr., Virginia Military Institute

Morgantown, W. Va.—William C. Wade, Monongahela West Penn Public Service Co.

New Castle, Pa.—R. L. James, Pennsylvania Power Co.

Newport News, Va.—Clarence P. Andrew, Noland Co.

Pottsville, Pa.—Rolland W. Rodgers, Pennsylvania Power & Light Co.

Reading, Pa.—Frank E. Heins, Metropolitan Edison Co.

Richmond, Va.—George E. Schraudt, Jr., 812 St. Christopher Rd.

Scranton, Pa.—Frank B. Moore, General Electric Supply Corp.

Shenandoah, Pa.—Harry T. Weidman, Pennsylvania Power & Light Co.

State College, Pa.—David L. Markle, Pennsylvania State College

Sunbury, Pa.—William H. Heim, Pennsylvania Power & Light Co.

Towanda, Pa.—C. T. Troy, Northern Pennsylvania Power Co.

Wheeling, W. Va.—G. F. Morgan, Wheeling Electric Co.

Wilkes-Barre, Pa.—John G. Henninger, P. O. Box 1348

Williamsport, Pa.—Gleason E. Solley, 1103 Isabella St.

Wilmington, Del.—Edward F. Lafond, Delaware Power & Light Co.

York Pa.—Laurence O. Buckner, Metropolitan Edison Co.

Great Lakes Region

Akron, Ohio—Malcolm V. Tillett, Ohio Edison Co.

Alliance, Ohio—John R. Sweeney, Ohio Public Service Co.

Ashland, Ky.—G. S. Dunn, P. O. Box 1210

Ashtabula, Ohio — John E. Lundi, Cleveland Electric Illuminating Co.

Binghamton, N. Y.—Earl C. Edwards, New York State Electric & Gas Corp.

Canton, Ohio—E. A. Berry, The Ohio Power Co.

Cincinnati, Ohio — Russell J. Dickason, 4021 Carrie Ave.

Corning, N. Y.—John P. Hoxie, Corning Glass Works

Dayton, Ohio—Henry H. White, 1304 Harvard Blvd.

Elyria, Ohio — G. C. Rubenson, Ohio Public Service Co.

Flint, Mich. — Harold P. Earley, Consumers Power Co.

Fostoria, Ohio—Ira J. Barber, 446 Fremont Dr.

Frankfort, Ky.—Meredith McKinney, P. O. Box 185

Fremont, Ohio—H. A. Gavitt, 2131 S. Buckland Ave.

Greenville, Ohio—Paul N. Young, 221 N. Main St.

Huntington, W. Va.—William M. Langstaff, Appalachian Electric Power Co.

Jackson, Mich. — Leslie D. Lyon, Consumers Power Co.

Lexington, Ky.—Robert W. Wilson, Kentucky Utilities Co.

Lima, Ohio—C. F. Daugherty, The Ohio Power Co.

Louisville, Ky.—Ray F. Tillman, The Brecher Co.

Mansfield, Ohio—Orlo L. Smith, Ohio Public Service Co.

Marion, Ohio—LeRoy W. Clauer, Marion Reserve Power Co.

Massillon, Ohio—Jesse R. Parsons, Ohio Public Service Co.

Newark, Ohio—Kurt Franck, Holophane Co., Inc.

Portsmouth, Ohio—J. Richardson Thomas, 1911 Franklin Ave.

Sandusky, Ohio—C. H. Smith, Ohio Public Service Co.

Saginaw, Mich.—Earl R. Domoney, Consumers Power Co.

Toledo, Ohio—E. F. Schmidt, Toledo Edison Co.

Utica, N. Y.—Raymond F. McGuinness, Central New York Power Corp.

Warren, Ohio—Walter C. Schultz, Ohio Public Service Co.

Westerville, Ohio—Fred B. MacRae, 6908 S. State Rd.

Youngstown, Ohio — John G. Stewart, Ohio Edison Co.

Midwestern Region

Cedar Rapids, Iowa—J. C. Young, Jr., 2400 "E" Ave., N. E.

Davenport, Iowa—F. C. Horton, General Electric Co.

Des Moines, Iowa—G. G. Fletcher, 3103 University Ave.

Dubuque, Iowa — Frank E. Beecher, 1410 Parkway

Duluth, Minn. — M. G. Braden, Minnesota Power & Light Co.

Evansville, Ind.—Ned S. Muse, Graybar Electric Co.

Evansville, Ind.—R. M. Sly, Southern Indiana Gas & Electric Co.

Ft. Wayne, Ind.—N. G. Smoley, General Electric Co.

Hastings, Neb. — George D. Miller, Dutton-Lainson Co.

Lafayette, Ind. — A. M. Smith, Kirby Risk Electric Co.

Lincoln, Neb.—D. J. Maynard, Korsmeyer Co.

Madison, Wis.—Arthur J. Von Burg, Wisconsin Power & Light Co.

Mason City, Iowa—Richard J. Hughes, 22½ Third St., N.E.

Muncie, Ind. — John A. Hand, Indiana & Michigan Electric Co.

Norfolk, Neb. — Dwight I. Hultman, 1206 Prospect Ave.

North Platte, Neb.—S. W. Snell, Snell Electric Co.

Omaha, Neb.—Ford E. Foster, Electric Fixture & Supply Co.

Peoria, Ill.—James F. Orr, Jr., General Electric Co.

Richmond, Ind.—A. Fentress Tucker, Municipal Electric Lighting & Power Plant

Rockford, Ill.—J. B. Johnson, 1611 Grant Avenue

Sioux City, Iowa—Charles R. Tracy, Sioux City Gas & Electric Co.

South Bend, Ind.—L. F. Stauder, 802 St. Vincent St.

Springfield, Ill.—J. Walter Marquardt, 400½ E. Adams

Urbana, Ill.—J. O. Kraehenbuehl, University of Illinois

Waterloo, Iowa—J. C. Gehan, 711 Lime St.

Wichita, Kansas — Arthur L. Harris, Kansas Gas & Electric Co.

Northeastern Region

Albany N. Y. — C. D. Hollister, New York Power & Light Corp.

Augusta, Maine—F. R. Gethro, Central Maine Power Co.

Bridgeport, Conn. — Kenneth Priestley, The Eastern Electric Construction Co.

Lowell, Mass.—Frank H. Jones, The Lowell Electric Light Corp.

Manchester, N. H. — Jack L. Calpin, Public Service Co. of New Hampshire

New Britain, Conn. — Timothy J. Clare, 376 Chestnut St.

New Haven, Conn.—Fred R. West, Westinghouse Electric Corp.

Norwalk, Conn.—H. A. Hutchinson, Connecticut Light & Power Co.

Pawtucket, R. I.—Walter L. Kelley, Jr., 77 Bayley St.

Pittsfield, Mass.—Charles T. Masterson, General Electric Co.

Rutland, Vt. — George Blackburn, Central Vermont Public Service Corp.

Springfield, Mass.—Jack O. Callander, Western Massachusetts Electric Co.

Waterbury, Conn.—R. O. Mills, 19 Maynard Ave.

Worcester, Mass.—W. S. Mowry, Worcester County Electric Co.

Pacific Northwest Region

Bellingham, Wash. — Phil T. Rosser, Puget Sound Power & Light Co.

Bremerton, Wash.—G. Don Wirt, Puget Sound Power & Light Co.

Boise, Idaho—Orland C. Mayer, Idaho Power Co.

Butte, Montana—John W. Cromer, The Montana Power Co.

Everett, Wash. — N. E. Wolfe, Puget Sound Power & Light Co.

Medford, Ore.—H. L. Bray, Trowbridge & Flynn Electric Co.

Tacoma, Wash.—Charles C. Fields, Love Electric Co.

Olympia, Wash.—F. R. Starrett, Puget Sound Power & Light Co.

Victoria, British Columbia—Percy F. Fletcher, Canadian General Electric Co., Ltd.

Southern Region

Atlanta, Ga. — Charles R. Minors, Georgia Power Co.

Birmingham, Ala.—E. B. Richey, Comer Bldg.

Charlotte, N. C.—Roy Palmer, Duke Power Co.

Chattanooga, Tenn.—Buford H. Martin, Tennessee Valley Authority

Pensacola, Fla.—A. M. Quarterman, Younge and Hart, Architects and Engineers.

State College, Miss. — Robert S. Wiseman, Mississippi, Box 1198

South Pacific Coast Region

Fresno, Calif.—J. E. Hammond, Route 1, Box 559

Phoenix, Ariz.—A. W. Smith, Central Arizona Light & Power Co.

Reno, Nev.—Walter J. Herz, Sierra Pacific Power Co.

Reno, Nevada—F. W. Steiner, Jr., P. O. Box 2171

San Diego, Calif.—A. I. Benedict, San Diego Gas & Electric Co.

Southwestern Region

Amarillo, Texas—W. D. Knight, Southwestern Public Service Co.

Beaumont, Texas — Clarence B. Barron, Gulf States Utilities Co.

Corpus Christi, Texas—B. L. Guess, Jr., 1210 York Ave.

Oklahoma City, Okla.—J. Dale Hampton, Oklahoma Gas & Electric Co., P. O. Box 1498

Pine Bluff, Ark.—R. P. Hill, Arkansas Power & Light Co.

Shreveport, La.—R. K. Lothrop, Southwestern Gas & Electric Co.

Tulsa, Okla.—T. C. Wier, 1907 W. 41st St.

Non-Section

Honolulu, Hawaii—Paul H. Anderson, Hawaiian Electric Co.

Honolulu, Hawaii—Grace C. Hamman, 2614 Kuahine Drive

Honolulu, Hawaii—Edward L. Ralston, Jr., Hawaiian Electric Co.

Mexico City, Mexico—Atilio Celis, Apartado 2766

COMMITTEES
1948-1949

Except as noted below, all committees are appointed by the President, subject to approval of the Council, and terminate at the time of the first Council meeting each new administration, in the month of October. The duties of each committee are indicated.

Lee E. Tayler, President, ex-officio member of all committees.

STANDING COMMITTEES

BOARD OF FELLOWS — To evaluate the eligibility of candidates for transfer to the grade of Fellow and recommend their election by Council.

Frank A. Hansen, Chairman, Western Institute of Light & Vision, 3407 Lowry Road, Los Angeles 27, Calif.

O. P. Cleaver — T. W. Rolph
H. H. Magdsick — Howard M. Sharp
E. D. Tillson

COUNCIL EXECUTIVE — To conduct the affairs of the Society between Council meetings.

Lee E. Tayler, Chairman, The Detroit Edison Co., 2000 Second Avenue, Detroit 26, Mich.

C. H. Goddard — E. M. Strong
A. H. Manwaring — Walter Sturrock

FINANCE—Direct supervision of the financial affairs of the Society, present annual report on its financial condition and make recommendations to Council as to investments of money and upon all specific appropriations.

C. C. Keller, Chairman, Holophane Company, Inc., 342 Madison Ave., New York 17, N. Y.
B. J. Jensen — E. M. Strong
M. N. Waterman

GENERAL BOARD OF EXAMINERS—Evaluate the eligibility of applicants for admission to membership or transfer to the grade of Member and submit to Council their nominees for election to the grade of Member Emeritus.

R. C. Kinney, Chairman, Graybar Electric Co., Inc., 420 Lexington Ave., New York 17, N. Y.
George T. Bogard — E. M. Fahey

PAPERS — To procure, review and approve all technical papers and discussions thereof, for presentation before National Conferences of the Society.

Hoyt P. Steele, Chairman, Benjamin Electric Mfg. Co., Des Plaines, Ill.
Howard L. Wright, Vice-Chairman, Curtis Lighting of Canada, Ltd., 195 Wicksteed Avenue, Leaside, Toronto 12, Canada.
Charles I. Brady — Paul H. Hildebrand
Arthur A. Brainerd — Harry W. Horn
W. V. C. Foulks — Kirk M. Reid
R. M. Zabel

PUBLICATIONS—To be responsible for the procurement, review and approval of all material for the publications of the Society other than technical papers approved by the Papers Committee for presentation at National Conferences of the Society and their discussions, and committee reports, for which it will have publication responsibility only. Shall also be responsible for the editing, printing and business management of the publications of the Society.

E. C. Huerkamp, Chairman, Westinghouse Electric Corp., 1216 W. 58th Street, Cleveland 1, Ohio.
H. H. Magdsick, Vice-Chairman, General Electric Company, Nela Park, Cleveland 12, Ohio.
B. C. Cooper — R. G. Slauer
R. W. McKinley — R. W. Staud
F. I. Wilson

Sub-Committee on Advertising Sales

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L. A. Hobbe — J. S. Schuchert
J. L. Kilpatrick — C. C. Shotwell
B. D. Levaur — E. D. Stryker
Carter Lewis — B. K. Wickstrum
R. W. McKinley — F. I. Wilson

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Lillian Eddy — C. W. Zersen

Sub-Committee on Publication Sales and Distribution

R. W. McKinley, Chairman, 652 Morrison Dr., Mt. Lebanon, Pa.

Sub-Committee on Home Lighting Data Sheets

Mary B. Taepke, Chairman, Detroit Edison Company, 2000 Second Avenue, Detroit 26, Mich.
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Charles F. Bookman — Ruth Morris
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Stella Fetzer — Larry Rosenfeld
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Berlon C. Cooper, Chairman, McGraw-Hill Publishing Co., 330 W. 42nd Street, New York 18, N. Y.
Hugh P. Scott, Vice-Chairman, McGraw-Hill Publishing Co., 330 W. 42nd Street, New York 18, N. Y.
H. E. Ingraham — B. H. Martin

Sub-Committee of Reporters, Technical Data Sheets

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T. W. Haslam — F. C. Taylor
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H. F. Hume — J. G. L. Walden
H. L. Hutchinson — J. E. L. Walker
C. K. Lambka — Charles E. Wann
H. M. White

GENERAL COMMITTEES

Advisory Committee on Committee Personnel

C. H. Goddard, Chairman, Sylvania Electric Products, Inc., Ipswich, Mass.
C. L. Crouch — A. D. Hinckley
G. K. Hardacre — R. W. Staud

BOARD OF NOMINATION

A. F. Wakefield, Chairman, The F. W. Wakefield Brass Co., 731 S. Water Street, Vermilion, Ohio
G. K. Hardacre — R. W. Staud

Section Representatives, National Board of Nomination

G. W. Beals — G. E. Korten
R. L. Biesele, Jr. — Carter Lewis
Joe B. Browder — W. F. Little
H. E. D'Andrade — A. B. Oday
G. F. Dean — H. H. Robison
J. C. Forbes — J. S. Schuchert
Denny Freeman — George E. Shoemaker
L. H. Graves — Hoyt P. Steele
Caroline Horn — Joe Thomas
W. H. Kahler — S. B. Williams
C. C. Keller

CONSTITUTION AND BY-LAWS — To prepare for Council amendments to the Constitution and By-Laws, as required, and to develop rules of procedure for the operation of the Society.

R. W. Corwin, Chairman, Benjamin Electric Mfg. Co., 230 W. 17th Street, New York 11, N. Y.
A. A. Brainerd — L. H. Graves
D. P. Caverly — A. F. Wakefield
B. C. Cooper

DEFENSE, COORDINATING COMMITTEE FOR — To contact various Government Agencies concerned with National Security suggesting cooperation and participation in specific projects as an aid to solution of their problems. Recommending the placement of lighting study projects in present committees or the appointment of study project committees to the Society President and to expedite such study projects and guide accepted reports into proper Governmental channels.

A. F. Wakefield, Co-Chairman, The F. W. Wakefield Brass Co., 731 S. Water Street, Vermilion, Ohio.
Major G. D. Mills, Co-Chairman, 283 Osborne Avenue, Britannia Heights, Ottawa, Ont., Canada.
O. P. Cleaver — R. G. Slauer
C. L. Crouch — Walter Sturrock
S. L. Drumm — M. N. Waterman
G. A. Fry — C. S. Woodside
Paul Manchester

HISTORICAL—To assemble and make available for current reference and to prepare in suitable and durable form for posterity, such historical facts, printed memorabilia, photographs, voice records, museum specimens and allied items as may be judged worthy of composing a continuing digest of the record of the Society's history.

S. G. Hibben, Chairman, Westinghouse Electric Corporation, Bloomfield, New Jersey.
George Ainsworth — Van Rensselaer Lansingh
George G. Cousins — Mrs. W. F. Little
H. B. Dates — G. H. Stickney
L. H. Graves — Lee E. Tayler

LIGHTING SERVICE — To stimulate the discussion and practical application of lighting recommendations, standards, test procedures and other technical and scientific data developed by the Society to regional and local committees and to conduct a Lighthing Service Forum in connection with the National Technical Conference.

J. M. Stedman, Chairman, Pennsylvania Power & Light Company, 901 Hamilton Street, Allentown, Pa.
Harold H. Green, Vice-Chairman, General Electric Co., Nela Park, Cleveland 12, Ohio.
A. I. Benedict — I. L. Illing
R. W. Butts — Frank E. Mueller
Maxwell Cole — Philip Peeples
Ralph R. Enghouser — George M. Rankin
H. B. Gould — W. A. Stannard
M. A. Havenhill — C. A. Stevens
C. D. Hollister — H. A. Stroud
H. Leland Holtman — Charles R. Tracy
H. G. Hrivnatx — L. C. Twitchell

LOCAL ACTIVITIES — To coordinate regional and local activities with the national program of the Society, assist Section and Chapter officers with local operating problems, conduct Local Activities Conferences, prepare plan to give members a better understanding of the Society, review applications for establishment of new Sections and Chapters and recommend the appointment of local representatives.

Walter Sturrock, Chairman, General Electric Company, Nela Park, Cleveland 12, Ohio.
E. E. Ackland — Edwin H. Lauth
G. W. Beals — Theodore H. Shepherd
R. L. Biesele, Jr. — William A. Stannard
Harry Grattan, Jr. — J. B. Browder
Duncan M. Jones

MEDAL AWARD—To consider qualifications of candidates for I.E.S. Medal; submit recommendations to Council, and prepare citation for the reward.

A. F. Wakefield, Chairman, The F. W. Wakefield Brass Co., 731 S. Water St., Vermilion, Ohio.
G. W. Beals — W. F. Little
W. C. Brown — R. W. Staud
George G. Cousins — Dean M. Warren
L. H. Graves — S. B. Williams
G. K. Hardacre

MEMBERSHIP—To develop plans and supervise the operation of the individual membership campaign in the Society.

Frank R. Knowles, Chairman, Pennsylvania Electric Co., 535 Vine Street, Johnstown, Pa.
Garlan Morse, Vice-Chairman, Sylvania Electric Products, Inc., 111 Sutten St., San Francisco 4, Calif.
James H. Hull, Vice-Chairman, Fostoria Industrial Service, 22 Davidson Building, Des Moines 9, Iowa.

Section and Chapter Representatives

F. R. Adair — William F. Kratt
A. Anderberg — S. B. LeCornu
A. R. Ardinger — Howard Long
Frank A. Bettis — G. H. Maize
H. E. Bracke — William McGuire
W. B. Campbell — A. H. McKillop
G. M. Demers — Arthur H. Molitor
J. F. Dickerhoff — F. H. Owen
Walter C. Fink, Jr. — Edward M. Reid
Rush B. Glick — C. A. Rost
Paul J. Harrison — J. J. Sanders
Edward D. Heintze — W. J. W. Smith
B. T. Heinz — E. W. Thompson
B. O. Horton — H. M. White
Dean N. Jenks — Lester T. Wilcox
E. Craig Jones — Edwin W. Wismer

NATIONAL TECHNICAL CONFERENCE—To supervise the 1949 Technical Conference, select the time and place for the 1950 and 1951 Technical Conference and act as a depository of invitations for future conferences; study and report to Council the possibility of holding periodically a nationally sponsored technical conference for the Pacific Coast Zone.

R. F. Hartenstein, Chairman, Ohio Edison Company, Akron 8, Ohio.
R. W. Butts, Vice-Chairman, The Ohio Public Service Co., 405 Broad Street, Elyria, Ohio.

R. R. Brady	D. W. Prideaux
W. C. Brown	T. H. Shepherd
J. H. Fall, III	R. G. Slaner
Harry Grattan, Jr.	J. M. Stedman
Fred Guth	Hoyt P. Steele
A. D. Hinckley	F. I. Wilson
C. C. Kellet	

Conference Executive Committee

R. W. Butts, Chairman, Ohio Public Service Co., Elyria, Ohio.
E. B. Bentley, Vice-Chairman
Ross Brown, Vice-Chairman
W. J. Wiffert, Vice-Chairman
W. H. Kahler, Secretary

C. L. Amick	F. A. Kolb
Robert W. Brown	C. W. McFee
S. F. Davies	A. Fentress Tucker
Mary Wren Held	T. D. Wakefield
H. Leland Holtman	A. W. Wiese
L. C. Kent	

PROCEDURES AND POLICIES — Analyze for Council procedures and policies and make recommendations.
G. K. Hardacre, Chairman, Public Service Co. of No. Illinois, 72 W. Adams Street, Chicago 3, Ill.

Ward Harrison	R. W. Staud
P. S. Millar	A. F. Wakefield

PROFESSIONAL REQUISITES — To study and report on requisites for defining and improving the Professional Status of Illuminating Engineers, especially in reference to Society membership.
R. L. Biesele, Jr., Chairman, Southern Methodist Univ., Dallas, Texas

Berlon C. Cooper	E. M. Strong
Aksel Knudstrup	D. E. Trefry
R. C. Putnam	F. I. Wilson

PROJECT PLANNING—To study the operations, programs and policies of the Society with the view of its immediate and long-range objectives and recommend to Council new projects and programs to be established.

J. S. Schuchert, Chairman, Duquesne Light Company, 435 Sixth Avenue, Pittsburgh 19, Pa.

W. C. Brown	Ralph G. Raymond
C. H. Goddard	Hoyt P. Steele
L. H. Graves	Walter Sturrock
J. R. Hartman	W. F. White
Raymond C. Kinney	M. C. Wilt
N. D. MacDonald	

PUBLIC RELATIONS AND INFORMATION—

J. M. Hickerson, Chairman, J. M. Hickerson, Inc., 110 E. 42nd Street, New York 17, N. Y.

H. H. Green	J. S. Schuchert
R. R. Hill	R. W. Staud
Duncan M. Jones	W. T. Stuart
L. J. Rozier	B. F. Stevens

RESIDENCE LIGHTING FORUMS—To reactivate and expand residence lighting forums, suggest programs for meetings, revise Guide for Residence Lighting Forums and conduct a National Residence Lighting Forum Conference in connection with the National Technical Conference.

Priscilla Presbrey, Chairman, Westinghouse Electric Corp., Bloomfield, New Jersey.

Mary E. Dodds	Ruth Morris
C. L. Dwinell	Florence O'Donnell
Lillian E. Eddy	Janet Reynolds
Myrtle Fahsbender	Margaret Salter
Harry Feldman	Mary Taepke
Caroline E. Horn	Mary E. Webber

SECTION AND CHAPTER PROGRAMS, COORDINATING COMMITTEE ON—To make a study of the subjects and topics of probable interest to our members, review previous section and chapter programs, and prepare a report of program suggestions for section and chapter meetings, technical forums and study clubs.
Carl A. Basedow, Chairman, 3425 N. Harding Avenue, Chicago 18, Ill.

C. L. Amick	R. R. Lusk
J. R. Chambers	C. D. Miller
F. A. Hansen	C. B. Pederson
J. L. Kilpatrick	C. C. Shotwell
G. E. Korten	R. E. Worstell

SUSTAINING MEMBERS—To obtain additional Sustaining Members.
George J. Taylor, Chairman, Day-Brite Lighting, Inc., 92 Liberty Street, New York 6, N. Y.

Urban L. Bch	Stuart Goodwillie
R. A. Corvey	W. E. Potter
W. E. Folsom	C. C. Shotwell
D. W. Fuller	F. I. Wilson
Noble Gerry	

Members ex-officio acting as assistants to the Chairman

E. E. Ackland	Duncan M. Jones
G. W. Beals	Edwin H. Lauth
R. L. Biesele, Jr.	Theodore H. Shepherd
J. B. Bowder	William A. Stannard
Harry Grattan, Jr.	

Section and Chapter Representatives

Earl H. Ailt	D. William Fuller
H. J. Ashbee	Joseph R. Hartman
G. W. Beals	John P. Hobrecht
Frank E. Bescher	George M. Hooks
James N. Brannan	Harold M. Horton
A. P. Brown	Harry G. Hrivnatz
L. H. Brown	H. E. Ingraham
H. A. Cook	F. R. Jeffrey
Berlon C. Cooper	Guy M. Jones
Wallace P. Covington	Henry R. Jones
Joseph T. Dupree	Theodore C. Lauck
Theodore M. Foulk	Carter Lewis
Thomas Lyda	C. M. Snyder
Richard E. Magnell	Robert E. Steele
W. J. Montalbone	Percy B. Thorne
H. W. Osborne	Walter A. Toly
Ellsworth E. Schwalm	B. A. Travis
J. Vernon Sharp	D. E. Vincent
Hugh N. Sheeter	Clarence C. Walker
William J. W. Smith	Thomas J. Whalen

TELLERS

Virginia Skinner, Chairman, Long Island Lighting Co., 211 Fulton Avenue, Hempstead, L. I., N. Y.

W. A. Hayman	Robert A. Most
John MacDougall	Priscilla Presbrey

TASK COMMITTEES

TASK COMMITTEE — JOINT I.E.S.-A.P.H.A. COMMITTEE — To discuss with A.P.H.A. objectives of mutual interest in illumination, to review the relationship of light and vision, to study a rational basis for the quality and quantity of illumination and develop a list of researches desirable for further knowledge and cooperative effort.
E. M. Strong, Chairman, Cornell University, Ithaca, New York

Conrad Berens	C. L. Crouch
E. C. Crittenden	

A.P.H.A. Representatives

Francis Elder	M. Allen Pond
Leonard Greenburg	Donald Y. Solandt

TASK COMMITTEE ON CONFERENCE WITH THE NATIONAL COUNCIL FOR SCHOOLHOUSE CONSTRUCTION — To explore the field of mutual interest; to serve as a clearing house of expression regarding reports of both organizations; to study recommendations of quantity and quality of illumination and to develop a suggested program of study and research on specific illumination problems applying to schools.
R. C. Putnam, Chairman, Case Institute of Technology, 10900 Euclid Ave., Cleveland 6, Ohio

L. H. Brown	W. V. C. Foulks
C. L. Crouch	

TASK COMMITTEE ON WARTIME LIGHTING PRACTICES DURING WORLD WAR II—To solicit, assemble and compile a record of studies and practices on dimouts, blackouts and defense lighting (including concealment, camouflage and other topics) related to World War II experience; to file such record in the I.E.S. headquarters.
O. P. Cleaver, Chairman, Corps of Engineers, Fort Belvoir, Va.

C. F. Cashell	Roy A. Palmer
C. I. Dwinell	Kirk M. Reid
S. G. Hibben	F. J. Wellhouse
S. R. McCandless	C. W. Zersen

TECHNICAL COMMITTEES

AVIATION LIGHTING—To study the application of light and lighting to the spaces and functions involved in the operation of aircraft.
Ralph R. Brady, Chairman, Westinghouse Electric Corp., Bloomfield, N. J.
L. B. Moore, Vice-Chairman, The Grimes Manufacturing Co., Urbana, Ohio.
C. D. Miller, Secretary, General Electric Company, Nela Park, Cleveland 12, Ohio

H. Ainsworth	J. P. Hoxie
J. F. Angier	G. M. Kevern
F. C. Ashe	A. L. Lewis
J. B. Bartow	R. E. Madigan
H. R. Blackwell	W. E. K. Middleton
R. C. Blatt	H. J. C. Pearson
F. B. Brady	W. A. Pennow
F. C. Breckenridge	J. M. Roper
W. C. Bryant	V. J. Roper
A. H. Clarke	R. A. Rugge
G. K. Clement	J. Penn Rutherford
D. J. Coggins	L. C. Simpson
Roy E. Dahlin	D. H. Tuck
W. T. Harding	L. C. Vipond

COLOR AND ILLUMINATION—To study, evaluate and report on the effect of color in relation to the Art and Science of Illumination.
Dean Farnsworth, Chairman, U. S. Naval Submarine Base, Medical Research Laboratory, Box 45, New London, Conn.

A. A. Brainerd	G. B. Buck II
R. L. Biesele, Jr.	C. L. Cottrell
Faber Birren	G. F. Dean
L. H. Brown	Ralph M. Evans
Carl E. Fuss	Gladys Miller
W. C. Granville	Norman Macbeth
J. P. Guilford	J. A. Meacham
S. H. Hazelton, Jr.	Dorothy Nickerson
Harry Helson	D. E. Spencer
W. H. Kahler	A. H. Taylor
Johan C. Krombout	K. C. Welch
H. L. Logan	

DAYLIGHTING—To study the problems involved in daylighting, develop recommended practices and report thereon.
W. C. Randall, Chairman, Detroit Steel Products Co., 2250 E. Grand Blvd., Detroit 11, Mich.

H. Ainsworth	F. L. Knowles
W. J. Arner	W. F. Little
A. H. Baker	J. A. Meacham
R. L. Biesele, Jr.	R. A. Miller
L. H. Brown	A. E. Parker
H. S. Bull	L. B. Perkins
C. W. Bursch	F. W. Preston
W. E. Folsom	S. W. Quisenberry
Charles D. Gibson	D. E. Spencer
B. F. Greene	J. P. Staples
J. S. Herbert	H. B. Vincent
George N. Hingston	A. Vogel
E. H. Hobbie	George B. Watkins
R. W. Hudson	Kenneth C. Welch

FARM BUILDINGS AND WORK AREA LIGHTING — To study the application of light and lighting of farm buildings, surrounding work areas and other rural locations and to report thereon.
O. D. Hunt, Chairman, Kansas State College, Manhattan, Kans.

T. M. Barr	Arthur Kramer
Edith Buchholtz	Joseph Schaenzer
J. P. Ditchman	A. J. Von Burg
P. H. Hildebrand	

ILLUMINATION PERFORMANCE RECOMMENDATIONS — To prepare Illumination Performance Recommendations comprising brightness distribution, output efficiencies and other pertinent photometric characteristics for luminaires conforming to I.C.I. classifications, excluding residential.

J. F. Parsons, Chairman, Buffalo Niagara Electric Corp., 802 Electric Building Buffalo 3, N. Y.

G. R. Baumgartner	Robert S. Rogge
B. S. Benson, Jr.	R. P. Teele
W. H. Kahler	G. P. Wakefield
W. F. Little	

INDUSTRIAL LIGHTING — To revise the 1942 "American Recommended Practice of Industrial Lighting" with full consideration to the brightness approach, and with Council approval, to submit for American Standards Association approval.

W. C. Brown, Chairman, General Electric Company, Nela Park, Cleveland 12, Ohio.

G. W. Beals	C. C. Shotwell
L. H. Brown	Hoyt P. Steele
J. C. Forbes	J. William Steiner
Harry Keane	M. N. Waterman

LIBRARY LIGHTING—To study the application of light and lighting to public and institutional libraries and report thereon.

J. M. Ketch, Chairman, General Electric Co., Nela Park, Cleveland 12, Ohio.

H. A. Cook	Francis Keally
E. M. Fahey	Robert R. Wylie
J. F. Fedeler	

LIGHT CONTROL AND EQUIPMENT DESIGN—Collect and correlate the knowledge and data on means and methods of controlling, directing, reflecting, transmitting, and diffusing light and on the principles and practices of equipment design.

F. C. Winkler, Chairman, Westinghouse Electric Corp., 1216 W. 58th Street, P.O. Box 5817, Cleveland 1, Ohio.

R. D. Bradley, Vice Chairman,

George Arras	Kurt Franck
G. R. Baumgartner	Charles N. Laupp
G. W. Beals	David L. Williams
B. J. Benson, Jr.	

Joint Sub-Committee on Plastics for Lighting

A. B. Oday, Chairman, General Electric Co., Nela Park, Cleveland 12, Ohio.

M. H. Bigelow	L. Schepmoes
W. F. Little	F. C. Winkler
W. P. Lowell, Jr.	

LIGHT SOURCES—To correlate and report and light production and the characteristics of current light sources.

A. B. Oday, Chairman, General Electric Co., Nela Park, Cleveland 12, Ohio.

E. F. Lowry, Vice-Chairman, Sylvania Electric Products, Inc., 126 Washington Street, Salem, Mass.

H. F. Davidson	J. O. Kraehenbuehl
Arthur C. Downes	Russell C. Putnam
G. S. Evans	Ellery H. Raddin
B. F. Greene	E. H. Salter

LIGHTING AND AIR CONDITIONING—To study the relationship between lighting and various factors that enter into air conditioning and report thereon.

Howard M. Sharp, Chairman, 82 Smallwood Drive, Synder 21, New York.

R. R. Lusk	C. L. Seaquist
E. H. Salter	

Representatives of American Society of Heating and Ventilating Engineers

M. C. Beman

LIGHTING AND ARCHITECTURE—To study the application of light and lighting in the field of Architecture. To plan an interchange of knowledge and data between the Architectural profession and the Illuminating Engineering Society. To plan and develop lighting design competitions in Architectural Schools. To report to the Society on assignments falling within this scope.

H. E. D'Andrade, Chairman, General Electric Company, 570 Lexington Avenue, New York 22, N. Y.

Lucian T. Kight, Vice-Chairman, Duquesne Light Company, 435 Sixth Avenue, Pittsburgh 19, Pa.

J. H. Dean	Wentworth M. Potter
E. M. Fahey	E. Rambusch
Dean H. Holden	E. M. Steen
David H. Mason	K. C. Welch
S. R. McCandless	

LIGHTING DESIGN PRACTICE — To study published data on coefficients of utilization, room indexes, maintenance coefficients and other elements entering into calculation for lighting design, and to develop and propose methods for use in Society publications.

Charles L. Amick, Chairman, General Electric Co., Nela Park, Cleveland 12, Ohio.

B. S. Benson, Jr.	J. F. Parsons
J. H. Dean	R. S. Rogge
Neal Jacobus	E. H. Salter
J. O. Kraehenbuehl	R. P. Teele
J. J. Neidhart	

LIGHTING EDUCATION—To prepare educational and training programs on the fundamentals of illumination, lighting design problems and advance theories of light and lighting application. To prepare required text material and to further their adoption locally.

C. D. Miller, Chairman, Duquesne Light Co., 435 Sixth Avenue, Pittsburgh 19, Pa.

C. E. Weitz, Vice-Chairman, General Electric Company, Nela Park, Cleveland 12, Ohio.

Warren B. Boast	David H. Mason
C. W. Clarkson, Jr.	H. L. McKinley
O. D. Hunt	J. F. Parsons
W. B. Kennedy	C. E. Robison, Jr.
Carter Lewis	H. A. Stroud
Robert Ligare	Carl W. Zersen
Ralph Lusk	

Joint Sub-Committee—I.E.S.-U.S. Public Health Service

Carl W. Zersen, Chairman, 241 Schiller Street, Elmhurst, Illinois.

B. S. Benson, Jr.	R. R. Lusk
George D. Clayton	F. J. Marriett
F. H. Heintz	J. F. Parsons
Don Ingwersen	Tula Salpus
R. E. Ligare	A. A. Sobolik, Jr.

Pictorial Presentation of Illumination Measurements and Terms

Carl W. Zersen, Chairman, 241 Schiller Street, Elmhurst, Illinois.

B. S. Benson, Jr.	R. R. Lusk
F. H. Heintz	F. J. Marriett
D. N. Ingwersen	A. A. Sobolik
R. E. Ligare	

Section and Chapter Representatives

Clark Baker, Jr.	Buford H. Martin
W. D. Barnhizer	S. F. McGowan
J. A. Bartelt	Arthur Mendel
Louis D. Black, Jr.	J. F. Parsons
Russell A. Cook	Edmund W. Pratt
Howard F. Cummings	John S. Walsh
J. F. Dougherty	A. J. Walter
W. C. Hird	Thomas J. Whalen
C. N. Laupp	C. D. Willits
William K. LeBold	M. G. Zervigon

LIGHTING OF CENTRAL STATION PROPERTIES—To study and report on the lighting of electric power generating plants and their power distribution facilities.

A. A. Brainerd, Chairman, Philadelphia Electric Company, 900 Sansom Street, Philadelphia 5, Pa.

R. S. Bucher	Carter Lewis
H. A. Cook	Walter B. Morton
R. W. Curwin	W. S. Mowry
H. E. D'Andrade	L. G. Parks
C. E. Egeler	D. W. Taylor
R. M. Graves	D. H. Tuck
Paul E. King	

LIGHTING STUDY PROJECTS IN EDUCATIONAL INSTITUTIONS—To study the application of light and lighting to the spaces and processes involved in educational institutions; to initiate, follow-up and coordinate lighting study projects in the educational field; review the reports of the various study committees in this field; and make recommendations to Council.

Russell C. Putnam, Chairman, Case Institute of Technology, University Circle, Cleveland 6, Ohio.

Carl J. Allen, Secretary, General Electric Company, Nela Park 12, Ohio.

Willard Allphin	L. V. James
R. L. Biesele, Jr.	W. H. Kahler
Warren B. Boast	Charles N. Laupp
L. H. Brown	L. B. Paist
John M. Charlton	H. W. Schmidt
W. G. Darley	E. L. Stouffer
W. V. C. Foulks	C. P. Tolman
S. K. Guth	R. R. Tracht
Ray L. Hamon	

Brightness Conditions in Educational Visual Environment

C. N. Laupp, Chairman, Wisconsin Electric Power Co., 231 W. Michigan St., Milwaukee, Wisconsin

Willard Allphin	W. H. Kahler
J. M. Charlton	O. Phelps Meaker
W. E. Folsom	L. B. Paist
L. V. James	J. S. Walsh

Chalkboards

J. M. Charlton, Chairman, Toronto Board of Education, 155 College St., Toronto 2B, Ont., Canada

H. F. Davidson	H. Cecil Jones
Wayne Jervis	E. W. Moodie

Student Vision and Scholarship

S. K. Guth, Chairman, General Electric Co., Nela Park, Cleveland 12, Ohio

R. M. Hall	C. P. Tolman
R. L. Hamon	R. R. Tracht
W. A. Munroe	

Visual Problems

W. B. Boast, Chairman, Department of Electrical Engineering, Iowa State College, Ames, Iowa

J. M. Charlton	Winifred Hathaway
Arthur A. Eastman	Paul Seagers
Ray L. Hamon	N. E. Viles
Grace C. Hamman	Marjorie A. C. Young

Utilization and Control of Daylight

R. L. Biesele, Jr., Chairman, Southern Methodist University, Dallas, Texas

E. W. Conover	Douglas Haskell
J. W. Griffith	R. W. McKinley
F. K. Sampson	

LIGHTING STUDY PROJECTS IN INDUSTRY—To initiate, follow up and coordinate lighting study projects in the industrial field, review the reports of the various subcommittees in this field and make recommendations to Council.

M. N. Waterman, Chairman, Westinghouse Electric Corp, Bloomfield, N. J.

J. R. Chambers	A. W. Larson
C. E. Egeler	G. G. Rae
C. D. Hollister	R. G. Slauer

Lighting in Bakeries

F. J. Vodicka, Chairman, Commonwealth Edison Company, 2233 S. Throop Street, Chicago 8, Ill.

F. C. Bing	J. C. Weeks
W. B. Bradley	G. C. Fowler

Lighting in the Canning Industry

Carl O. Martin, Chairman, Benjamin Electric Mfg. Co., 448 Bryant Street, San Francisco 7, California.

L. H. Brown — Robert Thallon
S. H. Hazleton, Jr. — David C. White
K. M. Noble — H. K. Wilder
R. S. Prussia

Lighting in the Fluid Milk Industry

O. A. Hill, Jr., Chairman, Public Service Co. of No. Illinois, 1701 S. First Avenue, Maywood, Illinois.

Lighting in Foundries

Frank E. Mueller, Chairman, 1296 Nicholson, Lakewood 7, Ohio.

C. W. Briggs — J. H. Lansing
A. L. Collier — J. W. Steiner
C. E. Egeler

Lighting in Laundries

O. A. Hill, Jr., Chairman, Public Service Co. of No. Illinois, 1701 S. First Avenue, Maywood, Illinois.

G. F. Allen — Carl F. Jensen
J. R. Chambers — R. R. Lusk
A. L. Christensen — W. S. E. Miller
R. R. Hill

Lighting in Leather Manufacturing

Edward J. White, Chairman, Edward J. White Company, 351 Broadway, Newark 4, N. J.

I. J. Chesley — L. A. Robinson
B. J. Jensen — George H. Scherer
William G. Morrison — R. W. Stanley

Lighting for the Printing Industry

George W. Clarke, Chairman, Sylvania Electric Products, Inc., Washington, D. C.

W. A. Anderson — V. P. Scheidt
Peter Becker, Jr. — B. J. Taymans
R. R. Bransdorf — H. M. White
C. C. Hayes

Lighting in Sheet Metal, Stamping, Folding and Shearing

Floyd W. Sell, Chairman, The Detroit Edison Company, 2000 Second Avenue, Detroit 26, Michigan.

Howard A. Boltz — J. M. Marlin
E. L. Frase — Ted Rougly

Lighting in Steel Mills

A. Paulus, Chairman, Westinghouse Electric Corp. 306 Fourth Ave., Pittsburgh 30, Pa.

J. J. Booth — Lucian T. Kight
C. M. Crysler — H. J. Mazur
C. J. Enlind — Carlton Ostrom
H. Hargest

Lighting in the Woolen Industry

(Joint committee with the A.S.M.E. on Lighting in the Textile Industry)

W. L. Kelley, Jr., Chairman, New England Machine and Electric Co., 77 Bayley Street, Pawtucket, R. I.

Walter P. Rayner — F. J. Vorlander, Jr.
J. M. Shute — J. E. Watkins

Study Assignment in Lighting Study Projects

L. J. Cahill — R. L. James
W. F. Carson — Aksel Knudstrup
H. A. Cook — W. S. Mowry
Leo Dolkart — C. L. O'Shea
W. D. Gorman — D. H. Tuck

Supplementary Lighting

W. H. Kahler, Chairman, Westinghouse Electric Corp., 1216 W. 58th St., Cleveland Ohio.

G. F. Dean — E. A. Linsday
L. E. Goble

LIGHTING STUDY PROJECTS IN PUBLIC BUILDINGS AND PRIVATE INSTITUTIONS—To initiate, follow up and coordinate lighting study projects in the field of public buildings and private institutions, review the reports of the various study sub-committees in this field and make recommendations to Council.

Robert R. Wylie, Chairman, Sylvania Electric Products, Inc., Lighting Fixture Division, Ipswich, Mass.

C. J. Berry — J. M. Ketch
L. M. Endres — Carter Lewis
T. Fuchs — James J. Oberhausen

Lighting in Auditoriums and Churches

David H. Mason, Chairman, 1415 W. Adams Street, Chicago 7, Illinois

Louis Gold — A. C. Sangster
Edward Rambusch

Lighting in Hospitals

Howard Haynes, Chairman, General Electric Co., Nela Park, Cleveland 12, Ohio

H. W. Alexander — E. H. Greppin
D. L. Angus — J. J. Neidhart
J. C. Connor — Floyd W. Sell
B. C. Cooper — Albert Zack
Harry Grattan, Jr.

Lighting in Hotels

Myrtle Fahsbender, Chairman, Westinghouse Electric Corp., Bloomfield, N. J.

G. F. Dean — Joseph P. Manuele
Francis Keally — Gladys Miller
J. M. Ketch — M. W. Ross
Carter Lewis — C. I. Sayles

Lighting in Theatres

C. M. Cutler, Chairman, General Electric Company, Nela Park, Cleveland 12, Ohio.

Eugene Braun — Edward Rambusch
J. R. Cravath — Ben Schlanger
Theodore Fuchs — Hunton D. Sellman
J. S. Hamel — George Smedberg
S. G. Hibben — Daniel Stuehle
Edward B. Kirk — R. Gillespie Williams
Herbert Kliegl — Frederick M. Wolff
James McCulloch

NOMENCLATURE—To define the terms and standards of illumination; and endeavor to obtain uniformity in nomenclature.

Allan E. Parker, Chairman, Worcester Polytechnic Institute, Worcester 2, Mass.

E. Q. Adams — M. Luckiesh
H. P. Gage — Priscilla Presbrey
K. S. Gibson — Harris Reinhardt
L. A. Jones — H. C. Rentschler
J. O. Kraehenbuehl — H. P. Steele
W. F. Little

OFFICE LIGHTING—To study the lighting requirements of office lighting tasks, develop suitable lighting recommendations and report thereon.

R. L. Oetting, Chairman, General Electric Company, Nela Park, Cleveland 12, Ohio.

G. F. Dean Vice-Chairman, Toronto Hydro-Electric System, 14 Carlton Street, Toronto, Ont., Canada.

Lorin C. Brown — R. W. McKinley
A. G. Elley — George J. Taylor
W. E. Folsom — William Trott
G. C. Fowler — G. P. Wakefield

Project Committee on Task Evaluation

R. L. Oetting, Chairman, General Electric Co., Nela Park, Cleveland 12, Ohio
G. J. Taylor

Project Comm. on Performance of Lighting Systems

G. C. Fowler, Chairman, Public Service Co. of No. Illinois, Skokie Highway near Dundee Rd., P. O. Box 278, Glencoe, Illinois

W. C. Macy — R. W. McKinley
H. J. Mahaffey — J. H. Murrah
James P. Warner

Project Comm. on Characteristics of Office Materials and Equipment

A. G. Elley, Chairman, Sylvania Electric Products, Inc., 407 Jackson Building, Buffalo 2, New York

B. A. Thomas — J. G. L. Walden

Project Comm. on Depreciation and Maintenance of Office Ltg. Systems

G. P. Wakefield, Chairman, The F. W. Wakefield Brass Co., Vermilion, Ohio

J. H. Murrah — G. J. Taylor

Project Comm. on Related Environmental Factors

A. S. Almryde, Chairman, 822 Reba Place, Evanston, Illinois

W. C. Granville — H. J. Mahaffey
William Trott
J. G. L. Walden

Project Committee on Recommendations for Specific Areas

G. F. Dean, Chairman, Toronto Hydro-Electric System, 14 Carlton Street, Toronto, Ont., Canada

A. S. Almryde — W. C. Macy
W. J. Lind — Harris Reinhardt
R. G. Rudrow

PROGRESS—To keep in touch with developments in the art of lighting throughout the world and prepare a yearly review of achievements in the art of illuminating engineering for inclusion in ILLUMINATING ENGINEERING.

S. G. Hibben, Chairman, Westinghouse Electric Corp., Bloomfield, New Jersey.

Alston Rodgers, Vice-Chairman, General Electric Company, Nela Park, Cleveland 12, Ohio.

A. C. Barr — Arthur P. Larson
E. W. Beggs — David H. Mason
M. H. Bigelow — J. A. Meacham
L. J. Buttolph — R. G. Slauer
O. P. Cleaver — J. W. Steiner
Paul D. Cornelisen — A. S. Tyler
Walter J. Jones

PUBLIC CONVEYANCES — INTERIOR LIGHTING—To study the application of light to all public areas in conveyances used for passenger transportation, including particularly trains, buses, ships, street railways, and subways and report thereon.

E. W. Beggs, Chairman, Westinghouse Electric Corp., Bloomfield, N. J.

A. L. Arenberg — J. L. Heine
Charles I. Brady, Jr. — H. H. Helmbright
J. C. de la Rosa — L. J. Verharg
E. E. Dorting — W. C. Wheeler
W. Fall — Randolph Whitefield
E. B. Hallman

RESEARCH—To survey and report on all significant research dealing directly or indirectly with the application of light and lighting and its effect upon the performance and comfort of human beings not conducted by the I.E.S. Research Trust Fund, to survey the whole field of lighting to determine and report on subjects which require scientific verification through research, and to coordinate various types of research affecting lighting which are now being conducted by various agencies.

Dean H. Holden, Chairman, Nutplains, Guilford, Conn.

O. P. Cleaver — G. F. Mudgett
Hedley F. Davidson — S. R. Naysmith
S. McK. Gray — E. M. Strong
S. K. Guth — Miles A. Tinker
D. B. Harmon — Harry O. Warner
H. L. Logan — W. F. White

RESIDENCE LIGHTING — To study the application of light and lighting to the home including the study of the aesthetic phase of residential lighting, to prepare some practical reference for good lighting practices in period interiors and to report thereon.

E. W. Commery, Chairman, General Electric Company, Nela Park, Cleveland 12, Ohio.

Mary E. Dodda	Gladys Miller
Myrtle Fahsbender	Priscilla Presbrey
Katherine T. Goodall	D. L. Ripley
J. J. Jasin	Janet Reynolds
A. W. Kakilty	Mary E. Webber
Thomas S. Kelly	Norman Vacha
W. F. Little	

Color and Lighting

Gladys Miller, Chairman, 535 Fifth Ave., New York, N. Y.

Contemporary Lighting Practices in Traditional and Modern Interiors

Myrtle Fahsbender, Chairman, Westinghouse Electric Corp., Lamp Division, Bloomfield, N. J.
Gladys Miller
Janet Reynolds
Mary Webber

Cooperation with Residence Fixture Manufacturers

Norman Vacha, Chairman, John C. Virden Co., Cleveland 3, Ohio

Lighting and Viewing Habits Associated with Television Receivers in the Home —Survey

Mary E. Dodds, Chairman, Toledo Edison Co., Toledo, Ohio

Study Projects for Undergraduate Students

T. S. Kelly, Chairman, 115 East 60 St. New York, N. Y.

SPORTS AND RECREATIONAL AREA LIGHTING—To study the application of light and lighting to the areas and activities involved in sports and recreations and to report thereon.

Benjamin S. Benson, Jr., Chairman, Benjamin Electric Mfg. Co., Des Plaines, Ill.
R. J. Swackhamer, Vice-Chairman, General Electric Company, 1 River Road, Schenectady 5, N. Y.

J. W. Bateman	Frank R. Jeffrey
Earle D. Benson	Merle E. Keck
H. E. Carney	J. Leroy Phillips
A. H. Clarke	Kirk M. Reid
J. G. Felton, Jr.	M. W. Ross
A. B. Hallaway	Dana W. Rowten
J. E. Hammond	D. E. Trefry
H. F. Ilgner	F. D. Wyatt

Study Assignments in Sports and Recreation

J. W. Bateman	P. N. Clerke
B. S. Benson, Jr.	

STANDARDS OF QUALITY AND QUANTITY FOR INTERIOR ILLUMINATION—To prepare standards for illumination levels, brightness limits, brightness ratios for interiors including specific visual tasks, as well as the general surroundings.

Louis E. Barbrow, Chairman, National Bureau of Standards, Washington 25, D. C.

Willard Allphin	Ward Harrison
M. E. Bitterman	H. L. Logan
H. R. Blackwell	D. L. Ripley
G. A. Fry	D. E. Spencer
S. K. Guth	E. M. Strong
LeGrand Hardy	

STORE LIGHTING—To study the application of light and lighting to the spaces and processes involved in the selling of goods and to report thereon.

M. W. Ross, Chairman, Commonwealth Edison Co., 72 W. Adams Street, Chicago 90, Ill.

R. C. Allison	John J. Neidhart
D. P. Caverly	W. M. Potter
W. E. Conley	E. L. Riego
George Gilleard	G. H. Seiter
R. F. Hartenstein	K. C. Welch

STREET AND HIGHWAY LIGHTING—To establish the scientific principles underlying Street and Highway Lighting; to collect data on the results of the application of such principles to actual practice; to prepare such reports thereon as will assist technicians and benefit the public.

Stuart R. Williams, Chairman, Holophane Company, Inc., Newark, Ohio.
R. M. Zabel, Vice-Chairman, Westinghouse Lamp Division, Bloomfield, N. J.

J. W. A. Bollong	E. B. Karns
R. P. Brotzman	J. L. Kilpatrick
J. B. Browder	G. E. Korten
F. M. Carter	A. H. Manwaring
G. G. Cousins	John F. McGough
W. L. Cross, Jr.	P. S. Millar
Warren Edman	J. J. Oberhausen
J. H. Fahey	O. P. Ortlieb
G. K. Glass	H. W. Osborne
C. A. B. Halvorson	Kirk M. Reid
G. K. Hardacre	C. H. Rex
Earl T. Hawkins	D. W. Rowten
L. F. Heckmann	W. W. Sanders
O. W. Holden	L. J. Schrenk
R. M. Hoot	R. E. Simpson
H. G. Hrivnatz	R. G. Slauer
H. F. Ilgner	R. M. Swetland
G. W. Izant	G. A. Trosper
Lloyd M. Johnson	F. D. Wyatt

Study Assignments in Street and Highway Lighting

George A. Eddy	Earl J. Tinsman
Earl T. Hawkins	W. H. Woods

Study Assignments in Accident Surveys

R. E. Simpson, Chairman, 97 South Main St., West Hartford 6, Conn.

J. W. A. Bollong	A. H. Manwaring
P. N. Clerke	J. J. Oberhausen
Geo. G. Cousins	T. Taylor Peake
W. L. Cross, Jr.	Philip Peeples
C. V. Doherty	H. T. Rankin
R. G. Dummel	Kirk Reid
C. R. Hazard	Dana W. Rowten
L. F. Heckmann	W. W. Sanders
Leland Holtman	F. J. Schmitt
Roland M. Hoot	L. J. Schrenk
L. M. Johnson	R. M. Swetland
E. B. Karns	G. A. Trosper
John Young	

Coordination

Howard F. Ilgner, Chairman

J. W. A. Bollong	E. B. Karns
G. G. Cousins	H. W. Osborne

Executive

Stuart R. Williams, Chairman
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U. S. NATIONAL COMMISSION OF U.N.E.S.C.O.
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more light for current used!

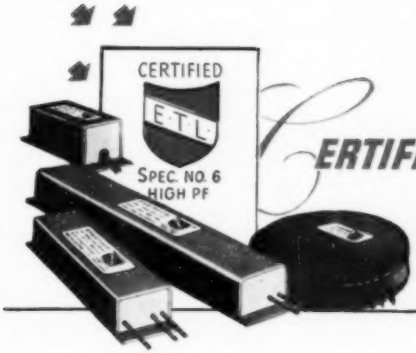
Certified Ballasts

Certified Ballasts give a high ratio of fluorescent light output to the input of power —deliver more light for the electricity used.

When you specify Certified Ballasts, your customers are assured of:

Rated light output
Full lamp life
Dependable performance

Because Certified Ballasts are made to exacting specifications, then tested and checked by Electrical Testing Laboratories, Inc., an impartial authority, they assure customer satisfaction—and proved economy.



CERTIFIED BALLAST MANUFACTURERS

Makers of Certified Ballasts for Fluorescent Lighting

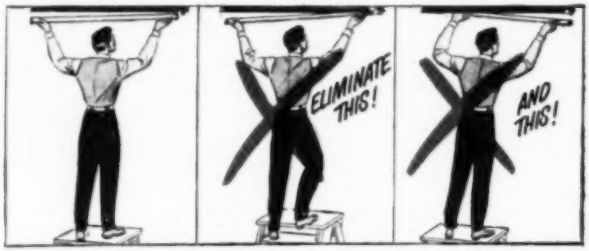
2116 KEITH BLDG., CLEVELAND 15, OHIO

SAVE 66⅔% WITH NEW —that now last 3 times

11,000,000 LAMPS FIELD-TESTED IN PAST 2 YEARS PROVE ONE LAMP DOES WORK OF THREE!

Here's the greatest news yet for *you!* Now, savings up to 66⅔% can be made by buying sensational Triple-Life Sylvania Fluorescent Lamps. Over 11,000,000 lamps field-tested two years in stores, offices and factories everywhere prove beyond a shadow of a doubt that they last three times as long as ever before—which means at least 2 years in the average installation.

Once you have these *longer-lasting* Sylvania lamps installed, you save, save, save—first on initial cost (you're buying more light), second on maintenance (cut replacements by ⅔), third, by better seeing, better working conditions, greater accuracy!



GIVES 7½ TIMES THE LIFE OF ELECTRIC BULBS!

Look How Long They Last!

Just imagine how wonderful these new Sylvania lamps are! You know how long an ordinary electric light bulb lasts—even after seemingly interminable use. Well, the amazing Sylvania Fluorescent Lamps that you can now purchase at your nearest Sylvania Distributor LAST 7½ TIMES AS LONG!

The rated average life of these lamps is 7500 hours, which means that, under average conditions, they can be expected to last—

2½ years in stores
3 years in offices and factories (one-shift operation)
6 years in schools
7 years in home kitchens and baths

CHEMICAL PROCESS SECRET OF EXTRA-LIFE SYLVANIA LAMPS!

After intensive research, Sylvania chemical engineers discovered that precise addition of zirconium in the manufacture of Sylvania lamps increased cathode life by three or four times!

In addition, they found that another chemical ingredient added to the high quality phosphor powders substantially increased light output and kept that increase longer!

These laboratory findings—typical of Sylvania leadership in quality engineering—were then put on a production basis—and off the Sylvania lines came these super lamps... 11,000,000 of them field-tested under actual operating conditions for two years!

FLUORESCENT LAMPS · FIXTURES · WIRING DEVICES · SIGN TUBING · LIGHT BULBS

FLUORESCENT LAMPS
as long as ever before!

COSTS NO MORE BUT GIVES 200% MORE LIGHT FOR YOUR MONEY!

ANOTHER SYLVANIA FIRST

Whatever it costs you to completely outfit your office, store, or plant with these outstanding new Sylvania lamps, you are purchasing with that money 200% more light than you could have bought two years ago! These extra-life Sylvania lamps are another demonstration of the engineering leadership that brings you higher quality lighting products — at no extra cost!

Yes, you spend the same for a lamp; but in your new Sylvania lamp, you get a lot more light for your money! *Look at these statistics:*

1946: Light Output — about 50 lumens per watt at 1750 hours operation on 3-hour cycle.

1949: The same lumens per watt delivered at *3000 hours* of operation! And less than 5% lamp failures after 5000 hours operation!

In other words, lighting value per your lamp dollar — measured in *longer lamp life* plus *improved maintenance of light output* — represents a gain of over 200%. That's a saving that really means something! That's a saving you can see!

COMBINE SYLVANIA FLUORESCENT LAMPS WITH SYLVANIA FIXTURES—FOR FLUORESCENT AT ITS FINEST

To take full advantage of these new lamps, use them in fixtures engineered to deliver the maximum amount of light to work surfaces. In other words, use them in Sylvania fixtures for commercial, industrial, school, and residential areas.

Typical of Sylvania's quality-engineered fixtures is the new CL-242 for schools, offices, and stores.

The CL-242 is a medium-priced louvered and plastic shielded unit carrying two of the new 40-watt Sylvania lamps! Mounted in continuous rows, CL-242 fixtures appear as a single sweep of light, due to exclusive Sylvania design features.

When pendant-mounted, the CL-242 delivers 87.6% of the light produced by the lamps. This extremely high efficiency is unparalleled in any fixture of its type! And like all Sylvania fixtures, the CL-242 is furnished complete with the new Triple-Life lamps.

Combine these features with *extreme ease of installing and servicing* and you can see why you'll want the new Sylvania CL-242.

Mail This Coupon Now!

Sylvania Electric Products Inc.
Advertising Dept. L-9208
500 Fifth Ave., New York 18, N. Y.

Gentlemen: ☐ Send full information about Sylvania's new Triple-Life Fluorescent Lamps and your Maintenance Budget Economy Plan.

☐ Also send data on your CL-242 Fixture.

Name .....

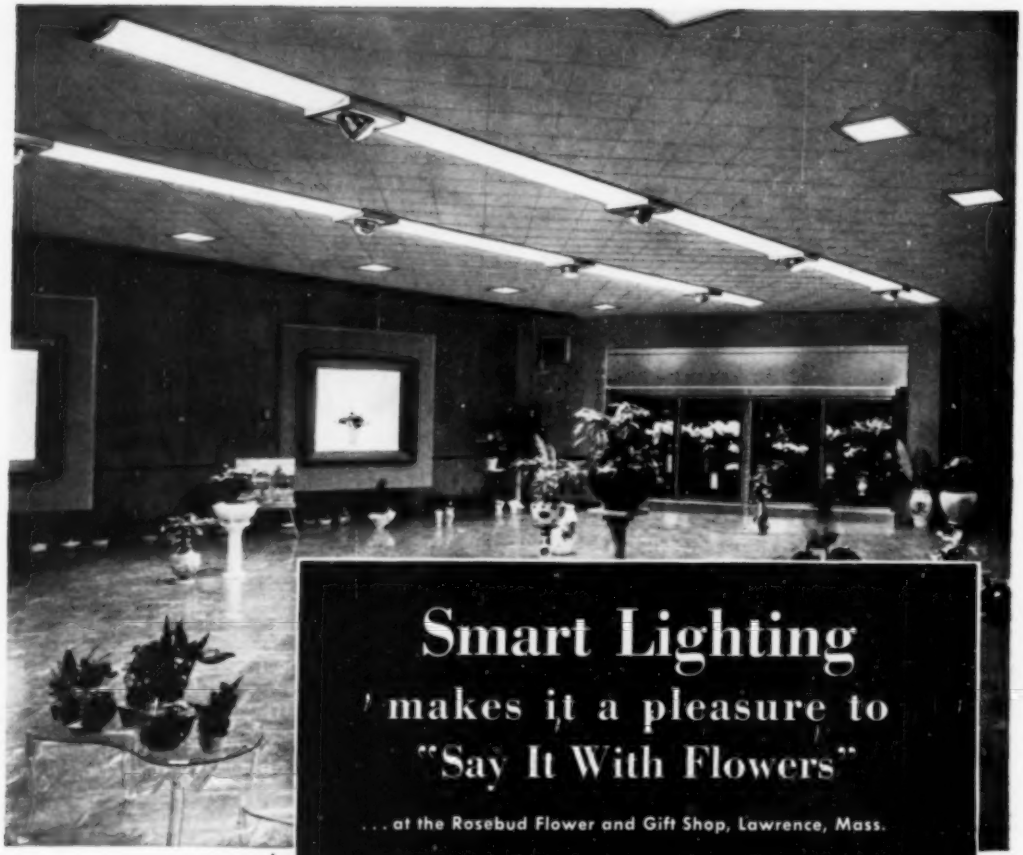
Company .....

Address .....

City ..... State .....

SYLVANIA ELECTRIC

PRODUCTS INC. RADIO TUBES, CATHODE RAY TUBES, ELECTRONIC DEVICES



Smart Lighting

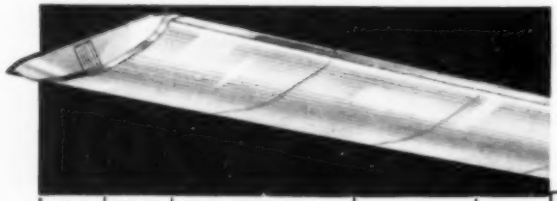
makes it a pleasure to "Say It With Flowers"

. . . at the Rosebud Flower and Gift Shop, Lawrence, Mass.

Architects: Ashton, Huntress & Pratt
Lighting Engineer: Henry R. Loeschner, Lawrence Gas & Electric Co.
Lighting Equipment: Litecontrol No. 9134, 3-lamp lens fixture; No. 12F-V30 lens boxes; No. P38 UF adjustable spots; 20 and 40 watt fluorescent strips inside shadow boxes.
Footcandles: 35 in service (average).

Delicate flower shapes and colors vibrate with fresh, natural beauty in the smooth, well-diffused light of this ultra-modern flower shop. Evidence again of how Litecontrol fixtures can add lighting punch that pushes sales curves up.

Whether your clients are selling flowers, flour or flannels, you'll find Litecontrol engineers . . . and Litecontrol fixtures . . . the answer whenever you want unusually effective lighting installations. We'll be glad to help with new, and different, ideas or complete lighting layouts.



. . . with LITECONTROL NO. 9134 FIXTURE

The basic unit of this distinctive lighting installation is a flush, troffer-type fixture, using Holophane Controlescent® curved lenses which give unusually effective light distribution. Sturdy and strong, it's easy to install and a guarantee of long years of trouble-free service.

Cat. No.	No. of Lamps	HOUSING Length	HOUSING Width	HOUSING Height	TRIM Length	TRIM Width	Weight
9124	2-40W	48"	13¼"	5⅝"	51"	15¼"	46 lbs.
9134	3-40W	48"	13¼"	5⅝"	51"	15¼"	51 lbs.

End Cap — No. 9100-3. Suspension Strap — No. 9100-6

LITECONTROL CORPORATION
36 PLEASANT STREET, WATERTOWN 72, MASSACHUSETTS

LITECONTROL *Fixtures*

KEEP UPKEEP DOWN

DESIGNERS, ENGINEERS AND MANUFACTURERS OF FLUORESCENT LIGHTING EQUIPMENT DISTRIBUTED ONLY THROUGH ACCREDITED WHOLESALERS

Corrugated white translucent PLEXIGLAS *covers the entire ceiling of the main lobby and elevator foyer in the Central National Bank, Cleveland, Ohio. Specifications, developed by the Buckeye Lighting Division of General Electric, called for 1100 sq. ft. of* PLEXIGLAS *#122-125, .125" thick.*

Man Without a Shadow

A man *can* lose his shadow—under a PLEXIGLAS luminous ceiling. Translucent sheets of this acrylic plastic, installed from wall to wall under fluorescent lights, diffuse illumination so completely that shadows are eliminated.

PLEXIGLAS luminous ceilings do more than eliminate shadows. They eliminate glare—both direct and *reflected*. They provide even illumination throughout a room, and insure a low brightness factor. In both performance and appearance, they are pleasing to the eye.

The economy of PLEXIGLAS luminous ceilings matches their efficiency. Better lighting with lower electrical input results from the maximum transmission and minimum absorption of light by white translucent PLEXIGLAS. Installation of the thin, light-weight, remarkably strong sheets is easy and inexpensive. Maintenance costs are negligible, and replacement of the non-discoloring material is unnecessary.

In banks, drafting rooms, stores, classrooms and control rooms, PLEXIGLAS luminous ceilings have already been installed and are meeting every requirement for truly efficient lighting. Write us about *your* lighting problem. We will be glad to tell you more about this new, highly successful means of large-area illumination.

Canadian Distributor:
Crystal Glass & Plastics, Ltd.
282 St. Helens Ave., Toronto, Ont.

PLEXIGLAS *is a trade-mark, Reg. U. S. Pat. Off. and in principal foreign countries.*

CHEMICALS FOR INDUSTRY

ROHM & HAAS COMPANY

WASHINGTON SQUARE, PHILADELPHIA 5, PA.

Representatives in principal foreign countries

what's **New** in street lighting

For 15,000 Lumen Lamps here's the most effective Luminaire ever built

It's the new Form 109 using filament lamps. It has a distinctly modern appearance, with clean functional lines. By day it calls attention to your street lights. By night it increases safety on your streets.

And it brings a new effectiveness to street lighting. The long-sought rectangular roadway light pattern is now a reality with the Form 109. The secret lies in an exclusive G-E ovate reflector which starts the light in the right direction.

And it's safer because there is less glare than with any other luminaire of comparable lumen output. The Form 109 reduces glare three ways—(1) Deep-shielded light source, (2) Large low-intensity refractor which has no "hot" spots and (3) Extremely accurate control of light by the balanced operation of the ovate reflector and Holophane verti-lateral refractor.

And the Form 109 will fit in with your standardization program. It will burn any 7" or 9½" light-center filament lamp and a complete line of mercury lamps—with change-over an easy field job. It's available with any standard mounting method. The optical assembly can be adapted to any existing Form 79, 101 or 106 hood. Here's a luminaire you want to know about. Write *Apparatus Dept., General Electric Company, Schenectady 5, New York.*

Mr. G. C. Buchanan, General Electric Lighting Specialist of Dallas, Texas, shows how easily the Form 109 may be opened for inspection.

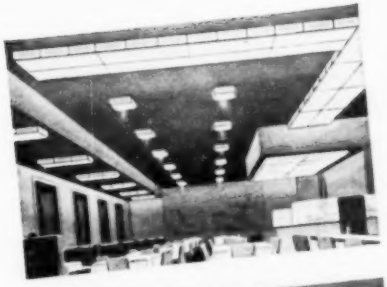
GENERAL ELECTRIC

452-88

With factories in Anaheim, Los Angeles, Oakland, Ontario, San Francisco, San Jose, Seattle, and Richland and Sales Offices in twenty western cities.

in Lighting *IS HERE*

MITCHELL
module
REG. U. S. PAT. OFFICE



The Custom-Fitting Lighting System

The new era in commercial lighting is born—with the first application of the modular principle to lighting! Developed by MITCHELL, MODULE is the *first* and *only* mass produced fluorescent lighting system that easily and economically achieves the results of the finest custom-built installations. MODULE is not merely "another fixture". It is the fundamentally different, the truly revolutionary new idea in lighting that combines in one single system *all* these unprecedented advantages:

- **Makes possible limitless pattern designs**
- **Custom-fits any room shape or proportions**
- **Provides unlimited linear flexibility**
- **Mixes many light sources in one uniform system**
- **Features equal low brightness throughout**
- **Provides harmonious matched appearance throughout**

Write today for free 20-page MODULE brochure which gives every detail of this exciting new lighting development. Use coupon at right.

MITCHELL MANUFACTURING COMPANY
2525 Clybourn Avenue, Chicago 14, Illinois
Send full details on MITCHELL MODULE

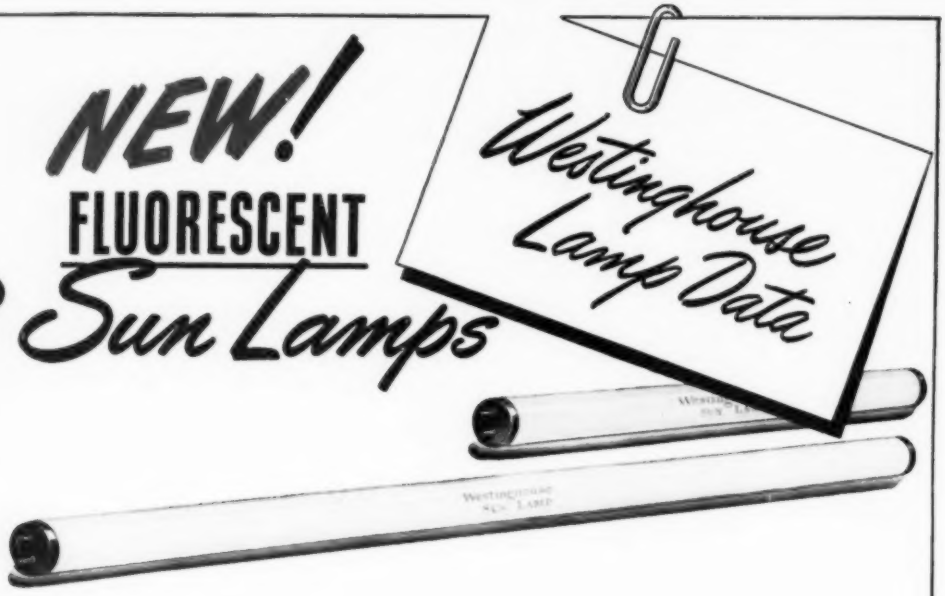
Firm Name.....

Address.....

City.....*Zone*....*State*.....

Attention:.....

NEW! FLUORESCENT Sun Lamps



This fluorescent sun lamp, the most powerful ever produced, provides a means of bathing wide areas with beneficial ultraviolet light.

In appearance the lamp looks like a regular fluorescent lamp. Its rays are soft and diffuse so that it can be mounted overhead for uniform and economical room irradiation. A newly developed phosphor powder, which generates the healthful energy, is used to coat the inside surface of the ultraviolet transmitting glass.

Wide Variety of Applications

The new lamp's efficiency is five times that of the screw-in bulb-type sun lamp. Thus it is ideal for use in schools, factories, offices, mines, and underground industries. In such places, it provides beneficial ultraviolet, similar to that in natural sunshine.

It is also usable for suntanning. An exposure of approximately five minutes to a 40-watt sun lamp, mounted in a suitable reflector two feet away, is sufficient for a tan. This feature will appeal to operators of gymnasiums, hospitals, solaria, barber and beauty shops.

Uses Standard Accessories

The lamp is available in 20- and 40-watt sizes. The dimensions and electrical characteristics are the same as those for the present Westinghouse fluorescent lamps of the same ratings. Consequently the new sun lamps can be operated in standard fluorescent fixtures.

For more information about the new Westinghouse sun lamp, write Lamp Division, Westinghouse Electric Corp., Bloomfield, N. J.

TECHNICAL DATA

	20-WATT LAMP	40-WATT LAMP
Bulb diameter	1½"	1½"
Lamp Length	24"	48"
Operating Amperes	0.36	0.415
Operating Volts	60	106
Base	Medium Bipin	Medium Bipin
Rated Avg. Life	2500 at 3 hours/start 4000 at 6 hours/start	2500 at 3 hours/start 4000 at 6 hours/start

YOU CAN BE SURE...IF IT'S Westinghouse

CERTIFIED STARTERS GIVE YOU A "Good Break!"

You get a "Good Break" two ways when you insist on Certified Starters for your fluorescent fixtures

1 You get a positive "break" when the tiny bimetal contacts within a Certified Starter break open to provide the needed voltage to start a fluorescent tube.

2 Certified Starters assure good lighting performance — full starter life—long lamp life—and lower maintenance costs.

"Certified" on a starter means it was made to precise specifications, then tested and checked by impartial Electrical Testing Laboratories, Inc.

CERTIFIED E T L

Say "Certified Starters" and get a Good Break

Certified Fluorescent Starter Manufacturers

2116 KEITH BUILDING • CLEVELAND 15, OHIO

At left is 40-watt fluorescent lamp. At right are General Electric's two 96" slimline lamps—the T-8 (1" diam.) and the new T-12 (1½" diam.)

General Electric brings you a new, bigger slimline fluorescent lamp!

...to streamline the lighting of stores, factories, offices, schools and shops.

Here it is! A big new slimline fluorescent lamp...8 feet long, 1½ inches in diameter . . . 75 watts, and it has a greater light output than any other General Electric fluorescent lamp.

It's the new General Electric T-12 slimline.

If you want cool, modern streamlined lighting for store, office or factory designs, better get all the information about G-E slimlines and particularly this newest member of the slimline family . . . the T-12.

In addition to its size, this new lamp brings you all these important advantages of G-E slimline lamps:

1. **Easy maintenance. Single-pin base makes them easy to install and replace.**
2. **New streamlined appearance.**
3. **Instant start—no starters needed.**
4. **High efficiency—more light per watt.**
5. **Long life.**

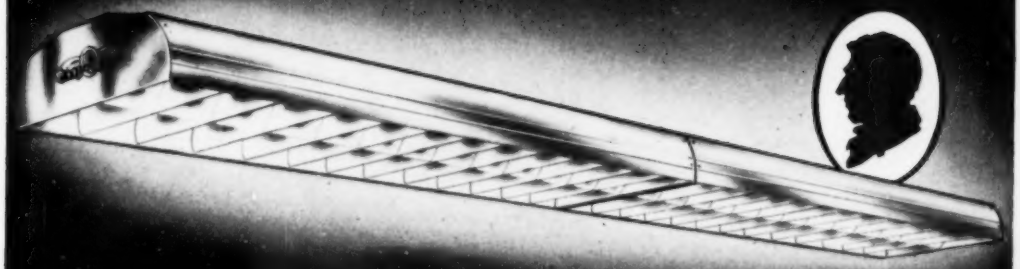
For latest information about General Electric lamps and help with any lighting job, see your G-E lamp supplier.

For FREE copy of a new booklet "Modernize with G-E Slimline" write to General Electric, Dept. 166-1E-8, Nela Park, Cleveland 12, Ohio.

You can put your confidence in—

GENERAL ELECTRIC

new highs in EFFICIENT & ECONOMICAL LIGHTING FOR SCHOOLS AND OFFICES



THE "Monroe" * in 4 and 8-Foot MODULES

FLUORESCENT LUMINAIRES

— Check these Advantages —

● **ECONOMICAL INITIAL COST**
Simplified design and construction of the basic chassis, side-panels and reflecta-louver assembly result in production economies which are passed on to the ultimate users.

● **LOW INSTALLATION COST**
One man, working from the side and not from the bottom, hangs the bare chassis in a minimum of time. Side-panel and reflecta-louver assembly snap into position *after* the chassis is hung; no tools required. The 8-foot chassis requires less hangers and less installation time.

● **MAXIMUM EFFICIENCY**
Permaflector Lighting Engineers have designed the Monroe to give efficiencies up to 83% with 25-35 shielding. Brightness comes well within the I.E.S. recommendations.

● **SIMPLIFIED MAINTENANCE**
Cleaning or relamping is fast and simple. Reflecta-louver assembly hinges down from either side; full-length fibre-plate snaps out quickly for easy access to wiring channel and ballast.

● **FLEXIBLE APPLICATION**
Plastic, aluminum or steel side-panels . . . reflector-closures that attach for totally direct lighting . . . and individual or inline installation with or without hangers—make the Monroe the "ideal" unit for many varied applications.

THESE ADVANTAGES ADD UP TO
ALL AROUND LIGHTING ECONOMY!

Write today for complete details on this exceptional series of fluorescent luminaires.

Pittsburgh Permaflector

PITTSBURGH REFLECTOR COMPANY
PITTSBURGH 22, PENNSYLVANIA
Permaflector Lighting Engineers in All Principal Cities
Distributed by Better Electrical Wholesalers

PITTSBURGH REFLECTOR COMPANY
411 Oliver Bldg., Pittsburgh 22, Pa.

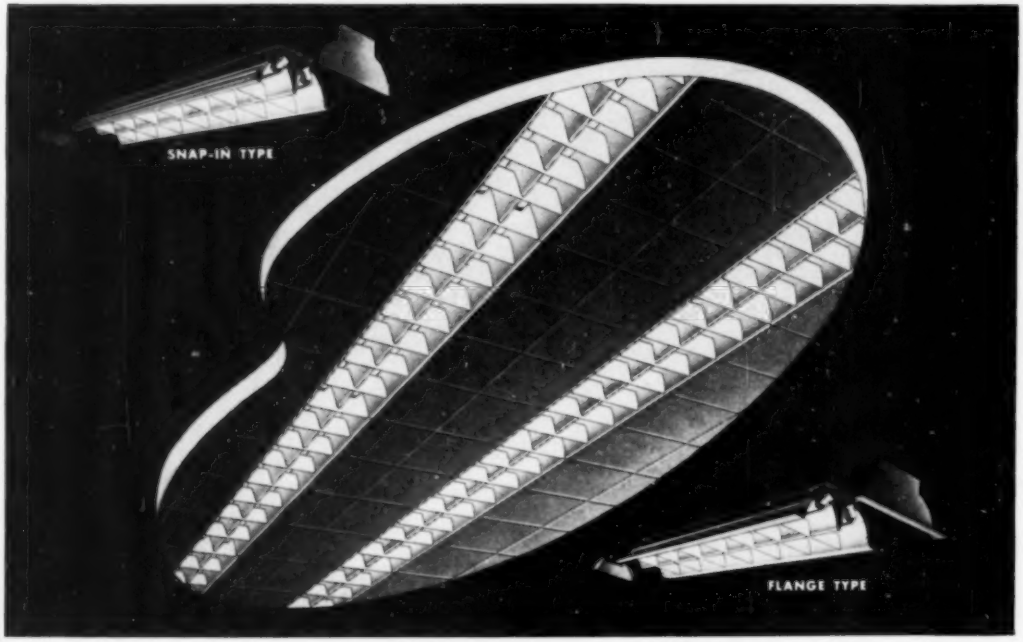
Please send me your bulletin which describes the Monroe Series in detail and shows specification, photometric and installation details.

Name_____
Title_____
Company_____
Street_____
City_____ Zone____ State____

DE LUXE LIGHTING FROM AN INCONSPICUOUS SOURCE...

LOW BRIGHTNESS

DAY-BRITE ALUMINUM TROFFERS



FUNCTIONAL...AND HARMONIOUS!

Day-Brite diffuse Alzak aluminum troffers provide extremely low contrast between light source and surrounding ceiling. That means smooth, *unobtrusive* lighting without blare or glare . . . a fixture that lends subtle beauty to architectural treatments.

And!... the parabolic design provides *accurate control* of light distribution. Light weight, durable, easy to install and maintain . . . these Day-Brite aluminum troffers are setting the pace where premium lighting at economical cost is called for.

Right now . . . TODAY. . . write for descriptive Bulletin 20-B. Address Day-Brite Lighting, Inc., 5432 Bulwer Ave., St. Louis 7, Missouri. In Canada: Amalgamated Electric Corp., Ltd., Toronto 6, Ontario.

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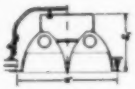
DAY-BRITE ALUMINUM RECESSED TROFFERS



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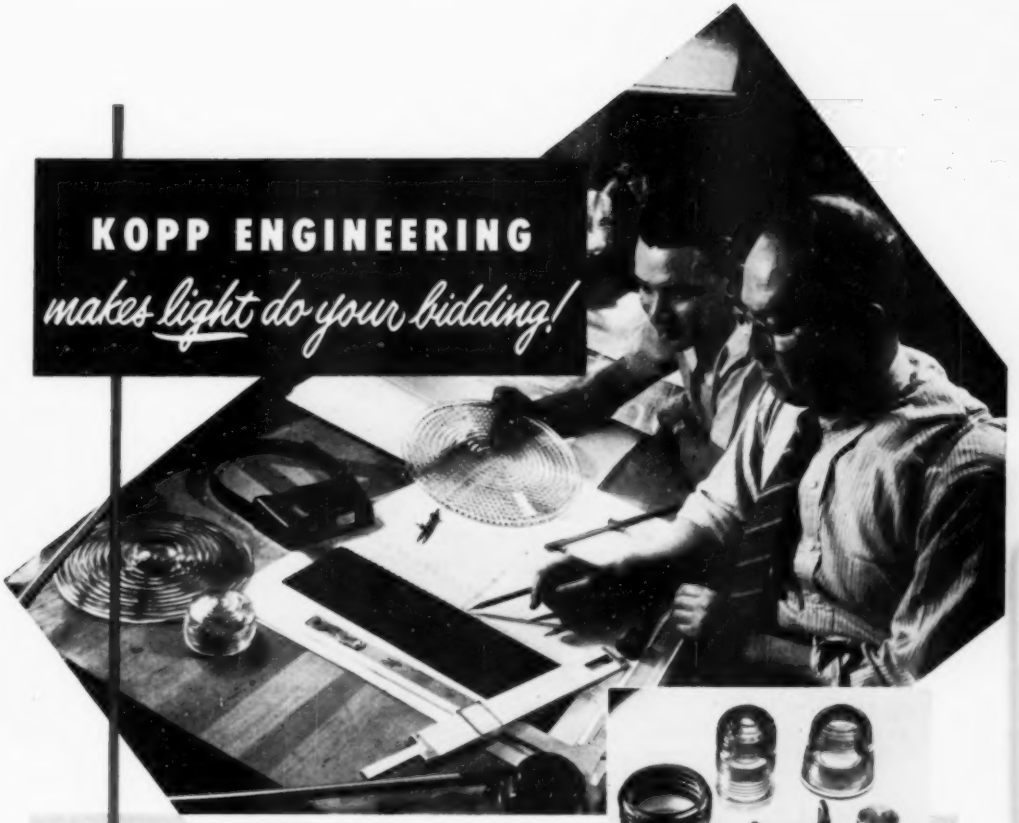

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Continued from page 503

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Tagg, J. E., Dominion Sound Equipments Ltd., St. John, N. B., Canada

White, C. P., The Webb Electric Co., St. John, N. B., Canada

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Dill, John J., J. J. Dill Ultra-Violet Co., Kalamazoo, Mich.

Hendry, Alan B., Kawneer Co., Niles, Mich.

Scheper, Henry, Scheper's Electric, Utica, Mich.

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Leland, Harold F., Morley Murphy Co., Wausau, Wis.

Maxwell, Kenneth J., Sylvania Electric Products, Inc., Milwaukee, Wis.

Student Member:

Hrupka, Joseph, University of Wisconsin, Madison, Wis.

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Walling, Richard R., General Electric Co., West Lynn, Mass.

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Kaufman, John E., 25 E. 77th St., New York, N. Y.

Kline, Frank Bryant, Colonial Electric Products, Inc., East Paterson, N. J.

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Campbell, Bruce Lindsay, 77 N. Second St., Lafayette, Calif.

Lacey, Woodrow L., The Lacey Co., San Francisco, Calif.

Stephens, John E., Incandescent Supply Co., San Francisco, Calif.

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Hufeisen, John, University of Cincinnati, Cincinnati, Ohio

Miller, Edwin H., University of Cincinnati, Cincinnati, Ohio

Zackerman, Seymour, University of Cincinnati, Cincinnati, Ohio

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Clark, Henry B., Westinghouse Electric Corp., Pittsburgh, Pa.

Krasnicki, Robert F., West Penn Power Co., Charleroi, Pa.

Nevler, Harvey, Gehar Electric Co., Philadelphia, Pa.

O'Keefe, James R., G. C. Murphy Co., McKeesport, Pa.

Scherf, Kenneth C., West Penn Power Co., Pittsburgh, Pa.

Yoder, William L., Jr., Public Service Electric & Gas Co., Burlington, N. J.

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Russell, Howard L., Lighting Products, Inc., Springfield, Ill.

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SOUTH TEXAS CHAPTER

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Williamson, Warren W., Tennessee Gas Transmission Co., Houston, Texas

Continued on page 20A

WATCH FOR ANNOUNCEMENT *of*

The New

LUMINOUS CEILING

DESIGNED UNDER RECOMMENDATIONS
AS SET FORTH BY
PROF. PARRY MOON, OF MASSACHUSETTS INSTITUTE OF TECHNOLOGY
and PROF. DOMINA EBERLE SPENCER, OF BROWN UNIVERSITY,

in their book "LIGHTING DESIGN"
(Addison Wesley Press—Cambridge, Mass.)

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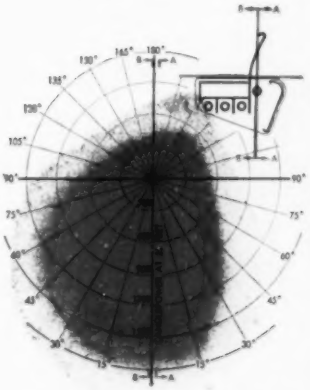

Candlepower Distribution Chart for VAL-LITE Model J-1817 equipped with four 40-watt fluorescent lamps.

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Continued on page 18A

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MackKenzie, L. W., Canadian General Electric Co., Ltd., Winnipeg, Man., Canada

Russell, G. Leslie, Green Blankstein, Russell & Associates, Winnipeg, Man., Canada

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About Lighting Theory, Practice and Procedure in the

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Now in its third printing since publication in 1947, this manual has proved invaluable as a reference work to men and women in all phases of lighting. Prepared and edited by leading authorities in the field, the Handbook's 850 pages are packed with information devoted to the latest in illumination, carefully indexed.

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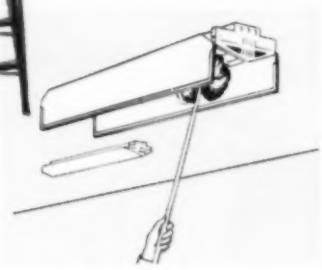

are cleaned right from the floor

Experts agree glass diffusion provides the finest reflected-glare-proof illumination, but costly cleaning was always a drawback... until GUTH pioneered the "floating-hinge" **ARISTOLITE.** Its glass panels swing open for economical *ladderless* dusting that makes its high efficiency easy to maintain.

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- For full details of this years-ahead fixture, send for Bulletin 830-I from

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*● 876

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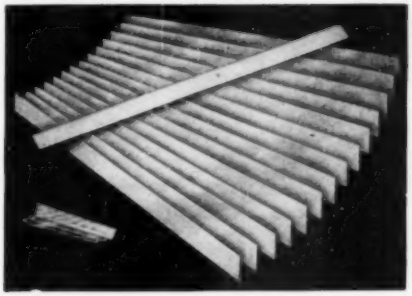

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In glass processing like everything else, experience, "know how," good deliveries, and modern production equipment is important. These factors are yours at Dearborn.

Flat glass or bent, plain or figured—coated in white ceramic. Glass circles are also bent to convex shapes in any size up to 22" in diameter, clear, figured or in ceramic colors.

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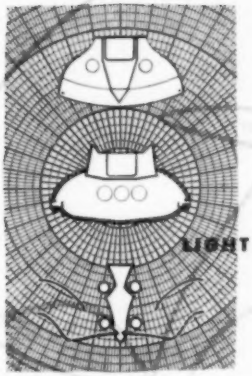

LIGHT CURVES FOR ADVANCED LIGHTING DESIGNS

SUNBEAM fluorescent fixtures are being specified more and more because they are scientifically designed to fulfill specific light distribution requirements. Through photometric research and illumination engineering, luminaires have been designed for schools, offices, public buildings, factories, stores and markets. Where good lighting equipment, combined architecturally with any interior is essential, SUNBEAM has the fixture.

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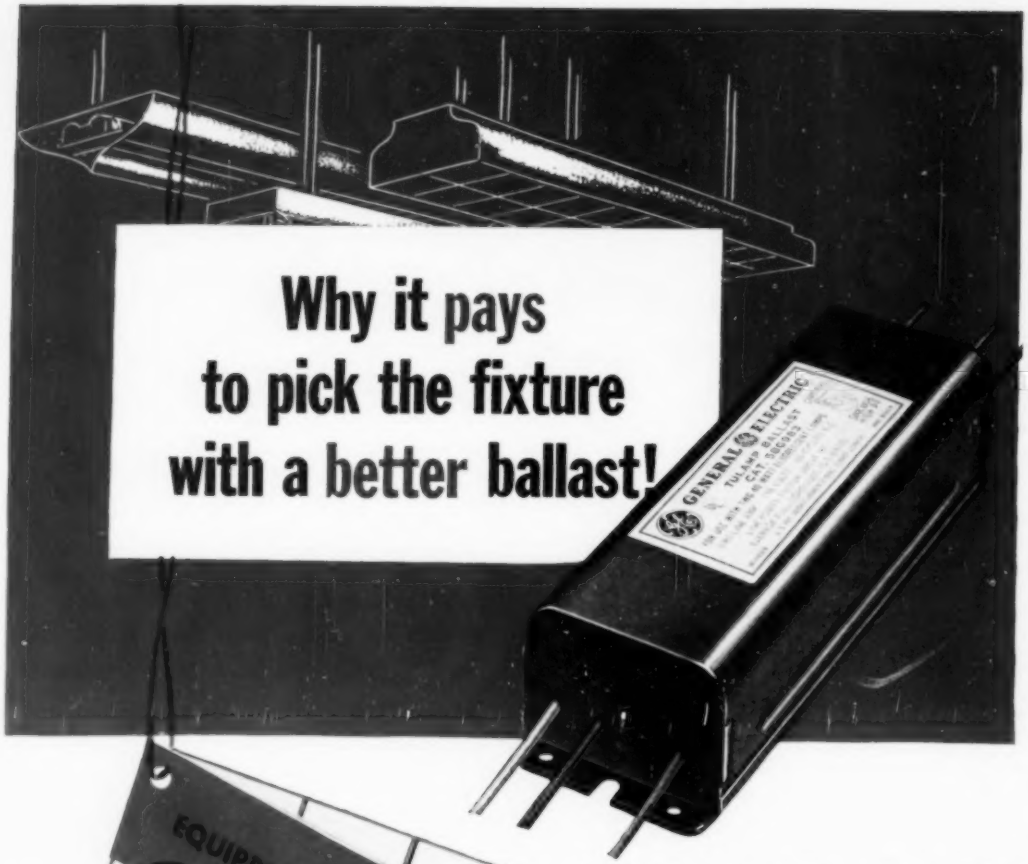

Why it pays to pick the fixture with a better ballast!

Quality ballasts are not only essential to complete satisfaction with fluorescent lighting—they save money for the buyer, too! Ballasts of superior design and materials assure you of full rated light output; you actually need *fewer fixtures* for your lighting job. Quality ballasts last longer and make lamps last longer; this means *lower maintenance costs.*

General Electric builds quality ballasts—ballasts that, over a 10-year period, can save you as much as 32 per cent of your initial outlay for lighting. So remember to look for the G-E ballast tag when you're buying fluorescent fixtures—and get the most out of your investment.

Send today for your free copy of G.E.'s new booklet "Quality Costs Less"—it shows with facts and figures how good ballasts mean economy for you. Address Sec. 412-80, *Apparatus Department, General Electric Company, Schenectady 5, N. Y.*

ADVERTISED IN TIME THE WEEKLY NEWSMAGAZINE

GENERAL ELECTRIC

412-80

will the Public Revolt *against* FLUORESCENT LIGHTING?

Will Sub-Standard Quality and Sub-Standard Performance Bring Fluorescent Lighting into Public Disfavor?

SINCE fluorescent lighting equipment was first made available ten years ago, the standards of fluorescent lighting and of fluorescent lighting equipment have been continuously IMPROVED. As a result, fluorescent lighting has quickly achieved national acceptance. This public confidence has been earned by the Lighting Industry because the great majority of the equipment produced and sold to the public has met with the high standards required to provide satisfactory performance.

TODAY the public confidence is being placed in jeopardy by the increasing occurrence of fluorescent industrial units which, instead of being built up to required standards, are being built down to a price.

How long will it take the public to wake up to unsubstantiated claims?

The public cannot be expected to understand all of the technical factors which differentiate a sub-standard unit from a unit built to deliver sustained trouble-free economical performance.

Informed electrical and lighting men know the importance of high quality starters and lampholders, in terms of easy maintenance, reliable starting and reliable operation.

They know that poor electrical and mechanical design can cause high temperature operations of the ballast resulting in decreased ballast life. They know, also, that lamp life is shortened by a ballast which supplies low starting current or by one that delivers low operating watts to the lamp. They know that low power factor ballasts do not permit efficient utilization of present wiring. They know that well designed and well constructed lighting units, such as those made to RLM Standards, will stand up and give full satisfaction to the customer.

The Remedy

It is up to the entire Lighting Industry to put this knowledge to work for the benefit of the public. This can best be done by first furnishing customers with the facts about initial cost, maintenance cost and performance of fluorescent lighting equipment and by supplying equipment which is warranted by the manufacturer and certified by an independent testing agency as meeting recognized and published standards of design, construction and performance.

This Advertisement is published in the Interest of the Entire Fluorescent Lighting Industry by

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The letters RLM stand for Reflector and Lighting Equipment Manufacturers

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QUALITY CONTROL DATA SHEET

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As a result of this "extra" quality control, Sylvania fixtures are famous for the lasting qualities of their Miracoat finish—which means that metal parts are protected from atmospheric attack, and reflecting surfaces maintain their rated reflectivity over the long life of the fixture.

Sylvania Electric Products Inc., 500 Fifth Avenue, New York 18, N. Y.

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